TECHNOLOGY DEPT.

TECHNOLOGY REVIEW

March 1954

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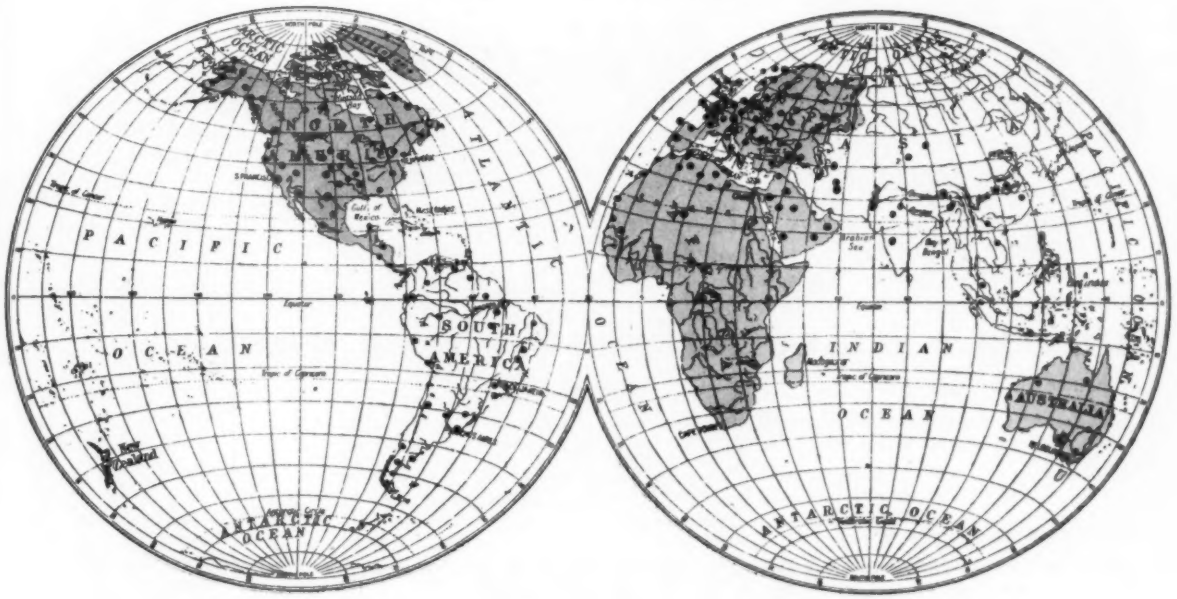

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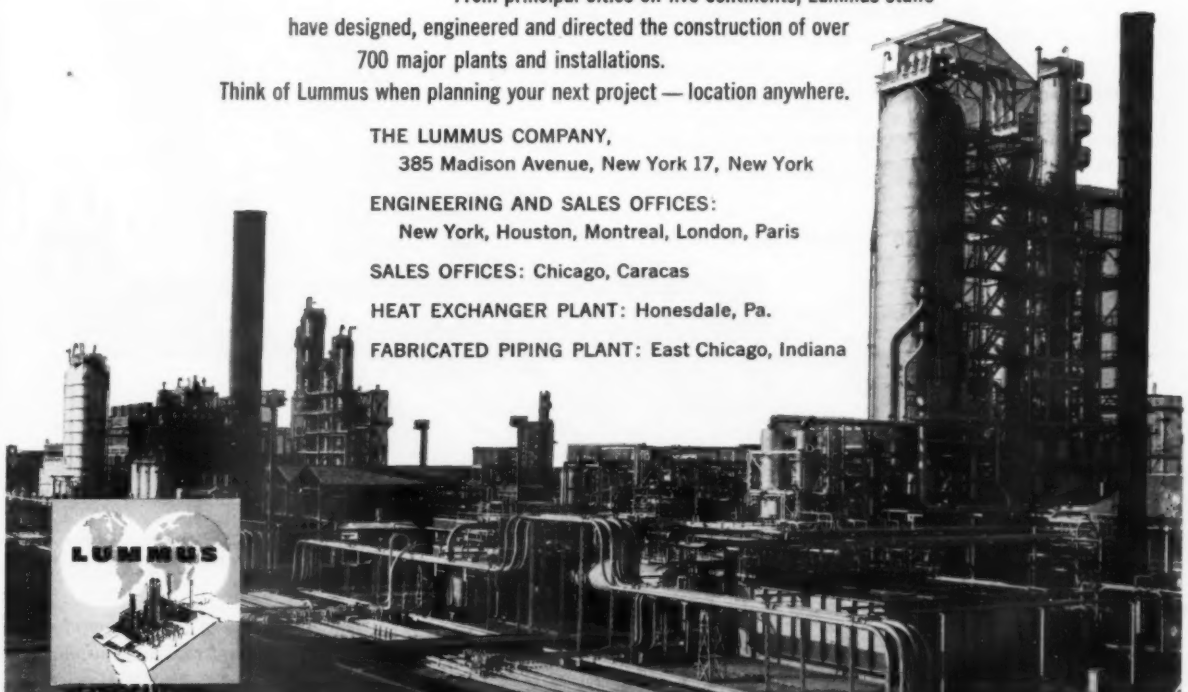

ILLUSTRATED: 40,000 B/D petroleum refinery at Dunkirk, France, designed, engineered and constructed by Lummus for the Société Generale des Huiles de Petrol

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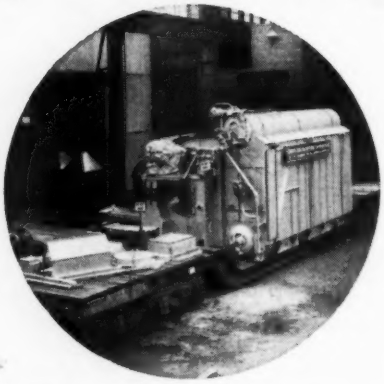
By the car load...



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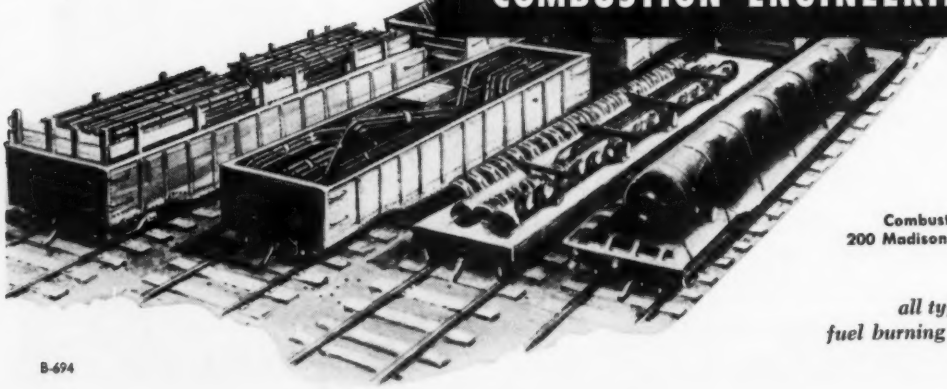

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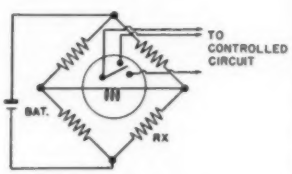
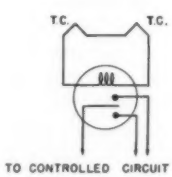
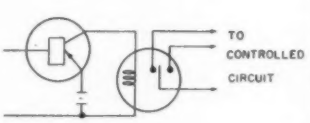


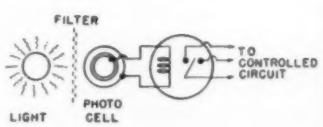
Resistance Selection



Temperature Differential Control



Transitor Selection



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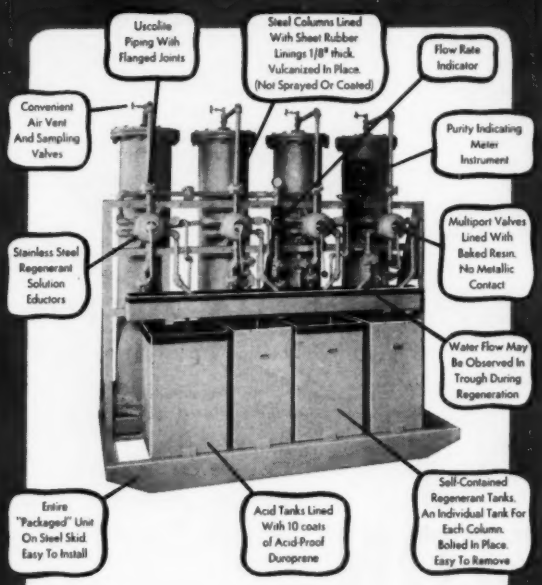
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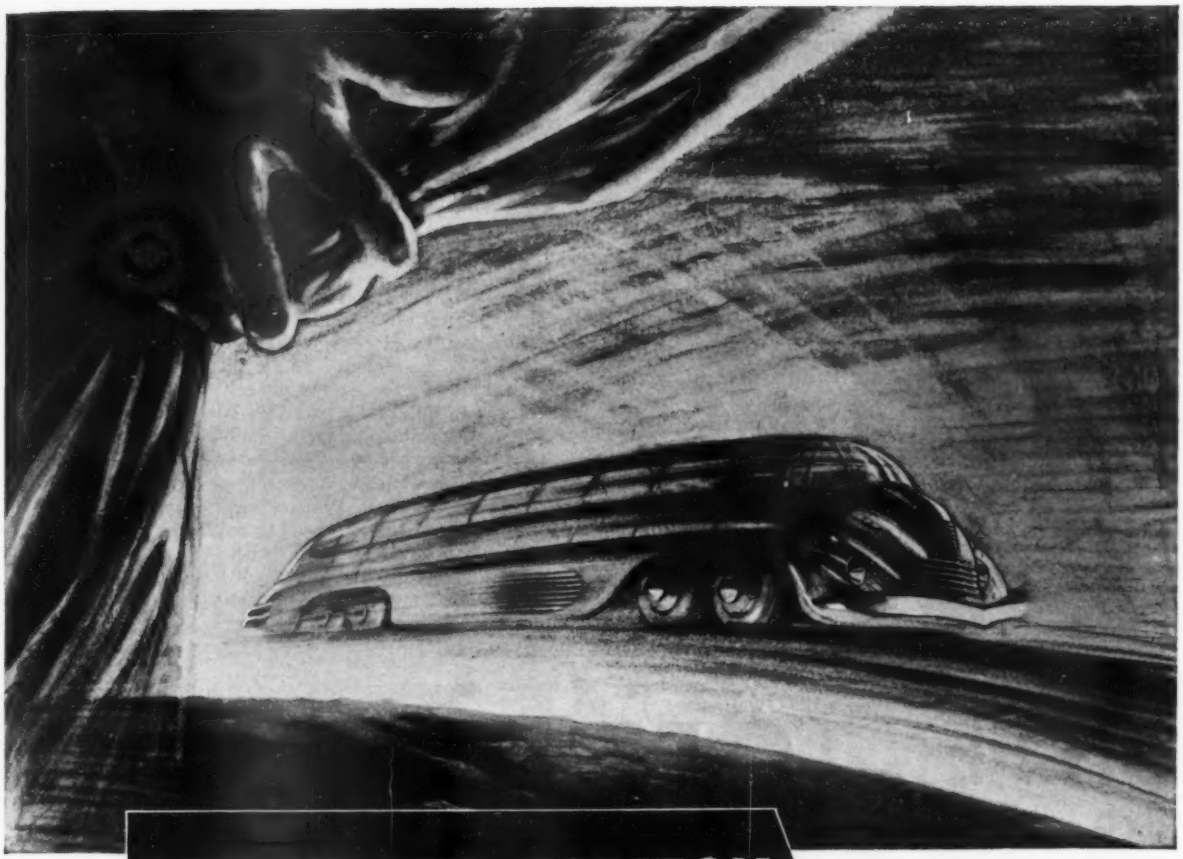
THE TABULAR VIEW

Educational Feedback. — When the Graduate School of Brandeis University was inaugurated on January 14, Technology's President, JAMES R. KILLIAN, Jr., '26, delivered the major address. The Review is happy to bring to its readers (page 239) this address, "The University and the Community." In speaking of the new relationship which universities have developed with agriculture, industry, management, and labor, Dr. Killian presented a study of the ways in which the intellectual and physical facilities of the modern university generate new firms, products, and services whose wealth is returned to their community for the common welfare. In the process, the university is able to produce special benefits for its own community.

Physical, Quizzical Prof. — Contrary to the views of many, physics need not be dull and uninspiring. In fact, MARY HANDY, staff writer of *The Christian Science Monitor*, finds it can be fabulous, at least when taught by Hans Mueller, M.I.T. Professor of Physics. Miss Handy received the A.B. degree from Principia College, Elsah, Ill., and studied for a short time abroad at Oxford and at Paris. Miss Handy has been writing about education for *The Christian Science Monitor* for the past three years, and for the past two years she was awarded a medal by New England Women's Press Association as outstanding woman reporter in New England. Her story is reprinted (page 243) as it appeared in the December 23 issue of the *Monitor*.

New England Mining. — Some interesting and unusual sidelights on the importance of New England minerals and mining, especially during the colonial times, are given (page 245) by CARLE R. HAYWARD, '04, Professor of Process Metallurgy, Emeritus. Born in Yankton, S. D., Professor Hayward was graduated from the Course in Metallurgy in 1904 and for the next two years was instructor in science at Bellows Free Academy in Fairfax, Vt. He has been associated with the Department of Metallurgy since 1906, and has written extensively on process metallurgy, especially of copper, lead, and zinc. His article records a surprising number of cases of mining in New England.

Tech's Medics. — Despite the complete absence, at M.I.T., of a course of instruction designed for premedical students, Technology Alumni who take up medicine have made an impressive record. The reason for this gratifying state of affairs may be the fact that "The Institute abounds with excellent courses in many fields, taught by stimulating men of exceptional ability" to use the words of MYLES MAXFIELD whose article, "Premedical Education at M.I.T.," appears on page 251. Dr. Maxfield received the A.B. and M.D. degrees from Harvard in 1942 and 1945, and the Ph.D. degree in biophysics from M.I.T. in 1950. He was a research associate in biophysics at M.I.T. 1950–1952, and since 1952 has been assistant professor of biophysics, and member of M.I.T.'s medical staff.



BEYOND THE HORIZON....

Coming developments in transport—still beyond the horizon—will depend very largely upon the new alloys the metallurgists can supply the engineer. The laws of thermodynamics dictate higher temperatures for greater efficiency in engines and, as the addition of Molybdenum to many alloys allows the use of higher temperatures, it will certainly be used more and more in the engines of the future.

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MAIL RETURNS

Comments on the January Issue

FROM RAYMOND E. HANSON:

The urge to congratulate you upon the current issue of The Technology Review is too strong to resist. Dr. Carmichael's article, "Psychology, the Machine and Society" should bring forth acclaim. It seems to me the most enlightening, erudite exposition of the fallacy of certain dangerous, present-day trends that I have seen to date. And I believe you have done a great service to your readers in publishing this very superior essay of a type so much needed today to combat tendencies which a study of history reveals have always led to disaster, disillusion, and destruction.

The article on decorative tiles is both interesting and informative. I look forward to reading Part II.

"Yellow Fever's Role in History," dramatizing as it does, a rather unknown phase of history, makes a worthy companion for these above-mentioned articles.

Boston, Mass.

Tiles of England and the United States

FROM E. A. LANE:

Your article on tiles is most interesting, and very well presented; I am glad to see that you have included several illustrations of pieces in the Museum. No doubt you will be following it up with a further article, and I look forward to this – especially if it contains information about tiles made in the United States. We over here have almost no knowledge of the latter.

In England there are two or three collectors of English delftware who have, during the last five years, made fairly intensive studies in the subject of English tiles, attempting to attribute them to the different centres of Lambeth, Liverpool and Bristol. Prewar information now seems somewhat out of date; but the present experts do not always agree with each other!

Victoria and Albert Museum
South Kensington, London, S.W. 7

13 contracts in the past 32 years for ALEX SMITH, Inc.

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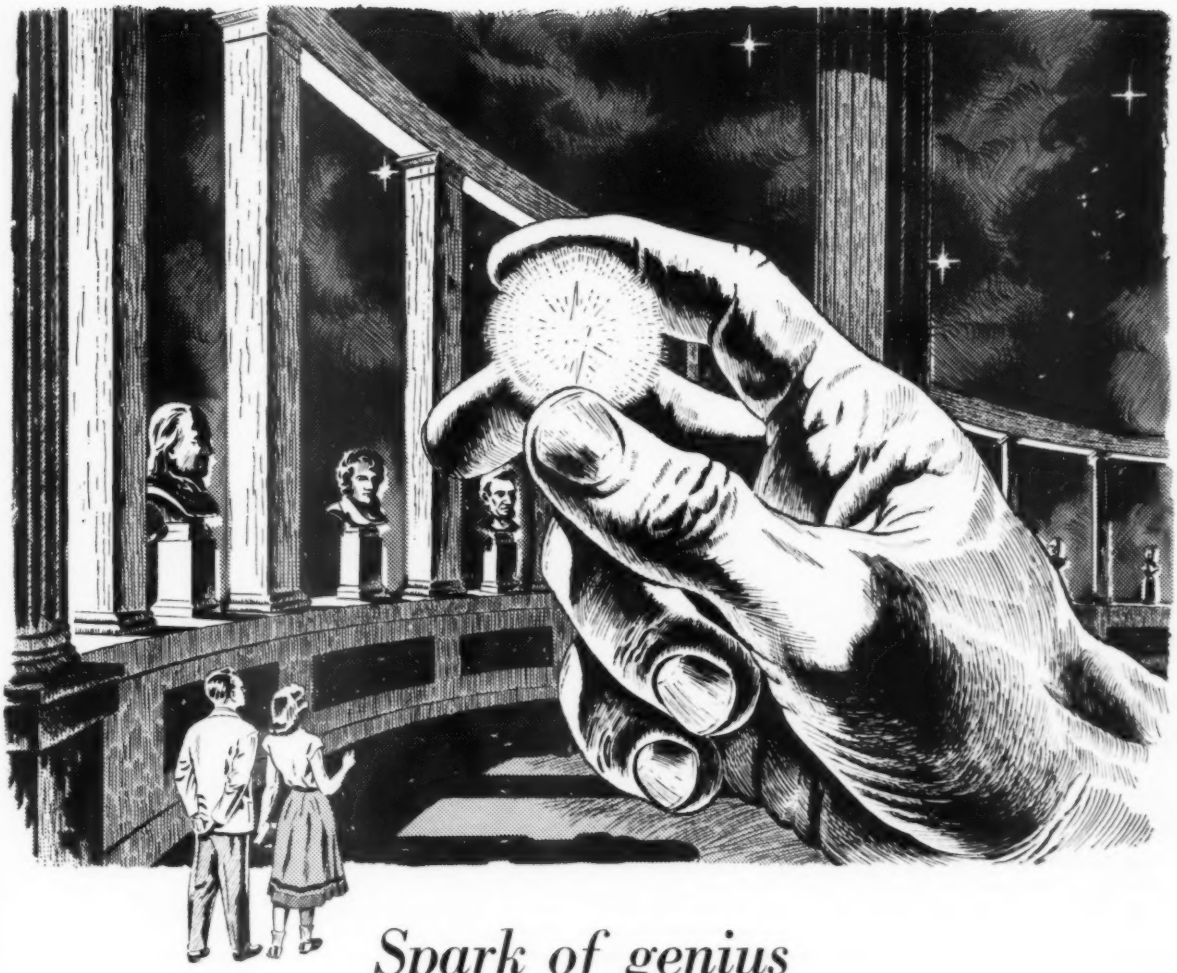

Spark of genius

"The great objective...
is to open the avenue of scientific knowledge to youth"*

Franklin...Fulton...Lincoln...Bell...Willard—geniuses? Yes, in the sense that they had the creative spark and the ability, courage, and leadership to see and speed to us inventions and ideas beyond the horizon of their day.

FUTURE IN TODAY'S YOUTH—The scientists, statesmen, inventors, and humanitarians of tomorrow are among our youth of today. The future depends upon our discovering, fostering and using their creative genius.

OPPORTUNITIES ABOUND for all of us "to direct the genius and resources of our country to useful improvements, to the sciences, the arts, education..."*

SCHOLARSHIPS AND FELLOWSHIPS—To help meet this need, Union Carbide has established undergraduate scholarship and fellowship programs in a number of liberal arts colleges and technical institutions to assist deserving students who are interested in business and scientific careers.

THE PEOPLE OF UCC hope you, too, will do everything in your power to discover and encourage the creative talent of our American youth. In them is our greatest assurance of an ever better tomorrow.

TO LEARN MORE about the Union Carbide scholarships and fellowships, their purposes, and the colleges and universities in which they have been established, write for booklet A.

*from Tablets in the Hall of Fame, New York University.

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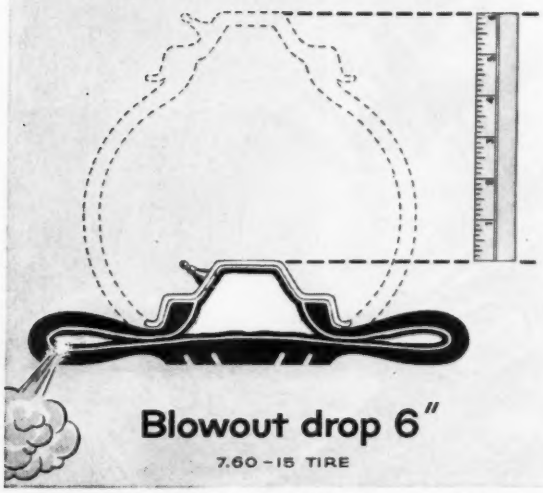
These few inches can mean the difference between life and death on the highway!

Single Chamber



Blowout drop 6″

7.60 – 15 TIRE

Your rims ride just 5½ to 7½ inches from the highway depending on tire size. And the only thing holding you up is air!

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LIFEGUARD double air chamber

Blowout drop 2½″

7.60 – 15 TIRE

But with double-chamber LifeGuard Safety Tubes in your tires, *only* the *outer* chamber blows out. You drop only 2½ inches. You still have a reserve of air in the inner chamber. You bring your car to a safe, controlled, straight-line stop!

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No matter what make tires you now own, you can make them safe against blowout accidents *and* guard against the inconvenience of punctures with New LifeGuard Safety Tubes. And you can use them in three or more sets of tires for 100,000 miles or more of blowout-safe, puncture-safe driving.

So you actually save 20% to 43% per wheel over other types of blowout and puncture protection. See your Goodyear dealer soon! Goodyear, Akron 16, Ohio.

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NEW LIFEGUARD SAFETY TUBES

by GOODYEAR

LifeGuard, T. M.—The Goodyear Tire & Rubber Company, Akron, Ohio

Boston, eight-mile marker (February Contents page) is in Christ Church Cemetery, Cambridge Common. From Harvard Square it was eight miles over the 1666 Bridge, through Brighton, Brookline, and Roxbury over the "neck" to the Old State House.

Raymond E. Hanson

How Well Do You Know Boston?
Not more than a mile from the main group of M.I.T. buildings is this statue of an early visitor to these shores. Do you know who the statue represents and where it is? If not, see Contents page for April.

THE TECHNOLOGY REVIEW

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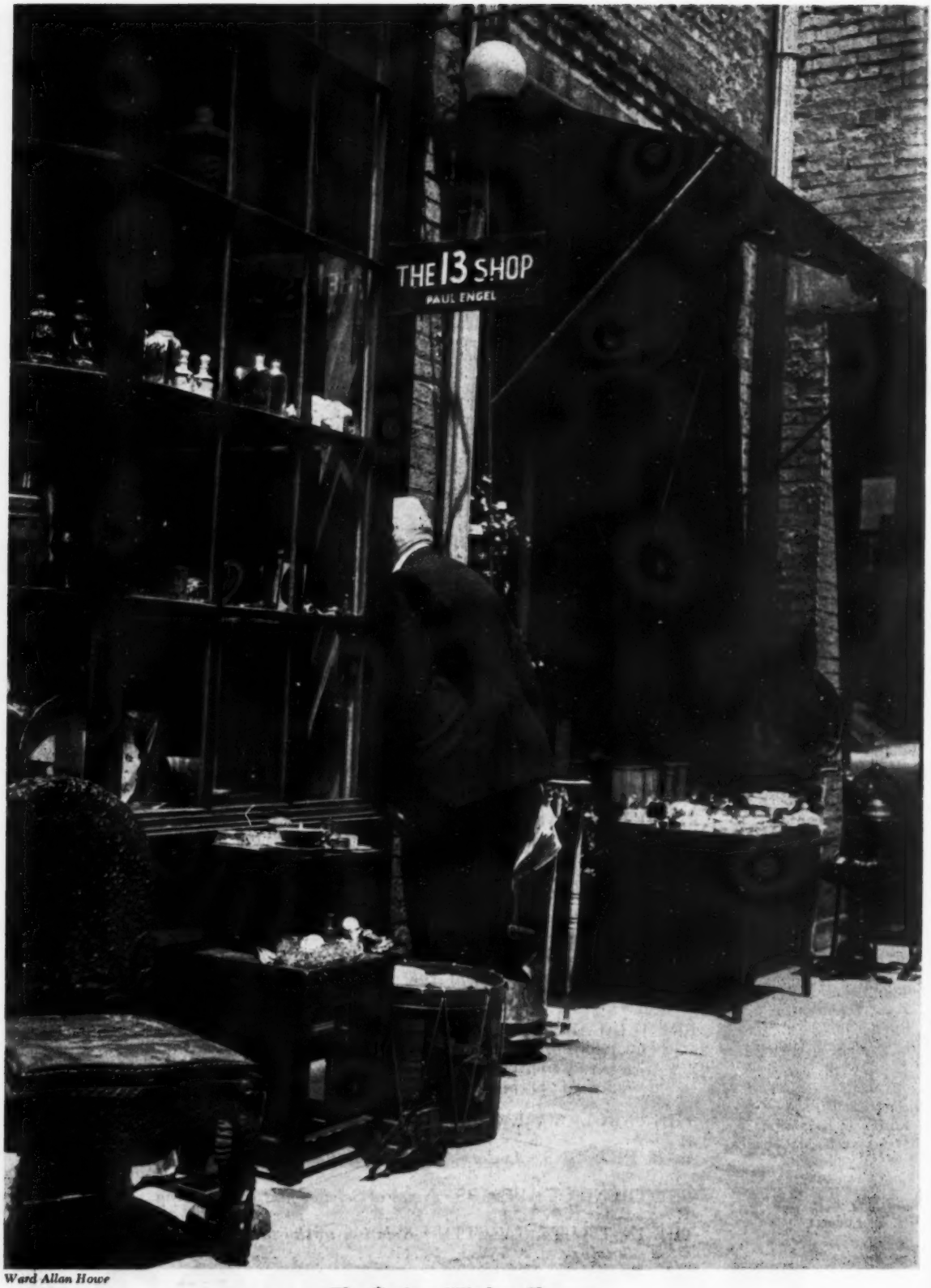


Ward Allan Howe

The Curious Window Shopper

Patio with antique shops, on East 51st Street, New York City

THE
TECHNOLOGY
REVIEW

Vol. 56, No. 5 March, 1954

The Trend of Affairs

Molecules of Life's Processes

WHEN we have increased our understanding of the elementary principles governing the behavior of living systems, then can we expect to control and benefit the actions of such systems. Such is the view expressed by David F. Waugh, Associate Professor of Physical Biology at M.I.T., who gave the Popular Science Lecture entitled "Proteins, Giant Molecules of Life's Processes" in the Society of Arts series at M.I.T. on Sunday afternoon, January 17.

Proteins recur, Dr. Waugh explained, wherever we attempt to obtain a basic understanding of the chemical and physical processes which, in sum total, give the characteristics of life to cells and tissues. Important examples which illustrate the wide spectrum of the occurrences and functions of proteins include the following: (1) Proteins comprise all of the enzymes, the mediators of the vast number of chemical transformations involved in the maintenance and repair of tissues and in the liberation of energy; (2) Proteins form the gel-like structures found to accompany the division of animal and plant cells; and the bulk of the contractile mechanism of muscle is also made up of proteins of different kinds; (3) The connective tissues which lend mechanical support to our organs, and by virtue of high mechanical strength as in tendon, transfer force, are also largely protein; (4) Finally, many important functions of blood, such as coagulation, are dependent upon the interplay of protein molecules.

Protein molecules of soluble character are known in many instances to be thousands of times larger than water molecules. Consequently, proteins must be composed of thousands of atoms, largely found in the groups hydrogen, oxygen, carbon, and nitrogen. Despite their size and the fact that the only repeating unit in these molecules is the amino acid (a relatively small unit), the molecules of each kind of a protein are constructed alike, at least within the limits of present methods for detecting differences. Within the last two decades, our knowledge has advanced to the point where we may attempt to picture the way in which the hundreds of amino acids are put together to form the structure of the protein molecule. It is known that the amino acids are joined together in chains much longer than the length of the molecules which they make up. The chains of amino acids, therefore, must be tightly folded or coiled; and separated portions of the amino-acid chain must come together and interact to lend stability to the coil.

Since the amino acids in the protein chain do not all have the same character, we expect and find a variety of interactions to lend structural stability. A considerable stability of internal structure is necessary to produce giant molecules – all of which are alike for a given protein.

The specific properties of different proteins – such as the strength of tendon, the hundreds of different kinds of enzymes like pepsin, trypsin, and cellular enzymes, the fibrinogen molecules responsible for blood coagulation, and the protein hormones, such as insulin and growth hormone – all owe their origins to factors such as the particular variety of amino acids, the sequence of amino acids in the chain, the nature of the coiling of the chain, and to factors not yet precisely defined.

In many instances, as in blood coagulation, it is found that protein molecules can come together, join, and form highly specific structures. Protein activities of this nature are undoubtedly at the basis of the grouping of enzymes and other molecules together to make the microscopically visible structures which are so important in the activities of living cells.

Considerable progress has been made in increasing our understanding of protein structure in recent years, Dr. Waugh stated. As our knowledge of the basic biological elements increases, who can tell what benefits to mankind may be anticipated in the future?

Life History of Clouds

CLOUDS may yield their life histories to a new cloud spectrograph developed by meteorologists at the Institute. Delbar P. Keily, '34, Associate Professor of Meteorology, and two assistants, John C. Johnson, 6–46 (now on the Tufts College staff), and Ralph G. Eldridge of the Division of Industrial Coöperation at M.I.T., have completed a one-month successful operation of their new equipment for measuring cloud drop sizes on Mount Washington, and are piecing together data which give an insight into formation and dispersal of clouds.

The new equipment, developed in the M.I.T. Department of Meteorology under sponsorship of the Geophysical Research Directorate of the Air Force Cambridge Research Center, determines the size and number of drops "smaller than have been measured before," Professor Keily says. It estimates the size and number of droplets as small as 4/10,000ths of an inch in diameter; a cubic inch of ordinary cloud may contain 500,000 such tiny droplets — each less than 1/100 the size of the smallest drops in a drizzly rain.

Clouds are formed when invisible water vapor collects into visible droplets of water, at first very small. These tiny droplets, says Professor Keily, "contain the key to the mystery of how clouds grow."

Such tiny drops, says Professor Keily, are believed to exist for a short time; they must either grow larger or evaporate. The new instrument is important because it will allow meteorologists to study the behavior of very small droplets, closer than ever to these critical sizes which are the true ancestors of raindrops.

Professor Keily and his associates call the new equipment a "variable frequency infrared cloud transmissometer." It consists of an electric eye looking through a part of the cloud in question toward a light source about four feet away. The eye measures the changes in brightness of the light source caused by intervening droplets of the cloud. The light source is invisible "infrared" radiation, chosen because it undergoes large changes on passing through a cloud of very small droplets.

To find the actual sizes of drops, observations of brightness made with the cloud spectrograph must be compared to intensities derived from theoretical data. The theoretical computations, the key to the usefulness of the new device, were originally made on M.I.T.'s large electronic computer, Whirlwind I, under Dr. Johnson's direction.

The cloud spectrograph proved its effectiveness in the fall of 1953 in a month's operation by Mr. Eldridge on Mount Washington — the highest point in New England and one of the stormiest mountains known.

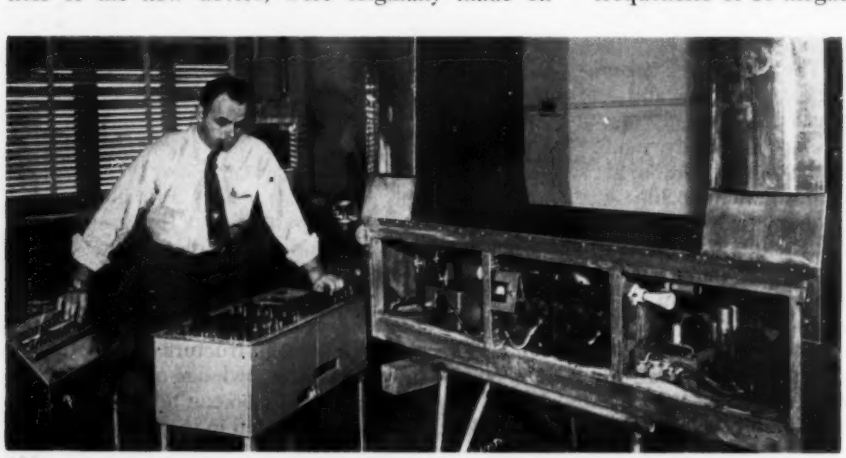
Future development of the cloud spectrograph, Professor Keily and his associates believe, will be toward an air-borne instrument of greater accuracy and dependability than the present experimental model. An air-borne cloud spectrograph, carried on successive passes through a cloud, could get the full life history of that cloud from its first appearance to its maturity as a rainstorm, without any of the side effects which may occur as a cloud passes over a mountaintop. Such a history of the changes in cloud drop size and number is necessary to a full understanding of when and why it rains.

Better Vacuum Tubes

MODERN electronic computers use a great many vacuum tubes for long periods of time under severe conditions of operation. For example, the Institute's Whirlwind I computer uses approximately 6,000 electron tubes which usually operate 24 hours per day. If maintenance operations and "time out" are to be held to reasonably small values, long life and stable operation of tubes under the conditions of operation are necessary.

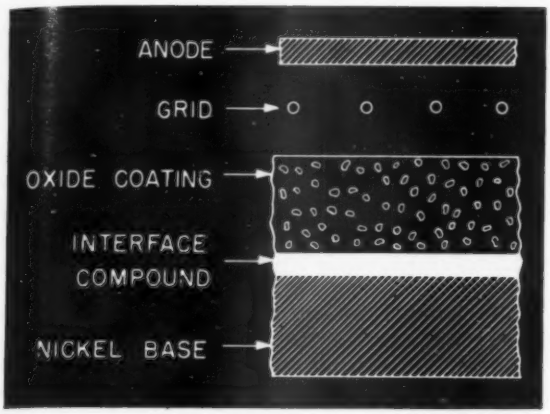
In most modern tubes, electrons are supplied from an oxide coating affixed to a nickel base which is heated electrically. It has been found that a major cause of failure of such tubes may be traced to the formation of a poorly conducting interface compound, whose location is shown in the diagram as the band between the nickel base and the oxide coating. The slow formation of such an interface compound gradually introduces an impedance between the base and the coating (called the interface impedance), which adversely affects the operation of tubes.

For many years it was known that an interface compound was formed, but only comparatively recently has it been known that, for tubes used in wide-band amplifiers, the interface was responsible for a loss of amplification at frequencies below 100,000 cycles per second without appreciable change in the gain at frequencies of 10 megacycles per second. The effect



Ralph G. Eldridge, of the M.I.T. Division of Industrial Coöperation, at work on the recording equipment of the M.I.T. cloud spectrograph which was recently successfully tested on Mount Washington. The machine determines the size and number of droplets in a cloud passing between the "eyes" of the unit at the right. One eye contains a light source; in the other is an electric eye which measures the changes in brightness caused by intervening cloud droplets.

M.I.T. Photo



Elements of electron tube diagrammatically represented (not to scale) to show how the formation of poorly conducting interface compound acts as additional impedance between anode and nickel base of this cathode.

was observed after several months of operation and was correlated with high silicon content of the amplifier tubes. The connections were established early in 1948 by a group headed by David R. Brown, '47, in the Digital Computer Laboratory, with the co-operation of Professor Wayne B. Nottingham of the Department of Physics. A research program was initiated in 1949 in the Digital Computer Laboratory to uncover basic properties of the cathode interface impedance, with the anticipation that a better understanding of such effects would enable more reliable tubes to be produced. The research has been supported by the Office of Naval Research, and a major part of the work described here has been done by Harold B. Frost, '50, research assistant of the Digital Computer Laboratory.

Because cathode interface impedance cannot be measured by standard equipment, pulse test equipment and accurate bridge techniques were developed for making the required determinations. Vacuum tubes, with different alloys for the cathodes, were placed on life test under various conditions. It was found that high values of cathode interface impedance were formed in tubes operated under cutoff conditions when the base contained more than 0.05 per cent silicon by weight; intermediate values were encountered erratically with alloys having between 0.01 and 0.05 per cent silicon, whereas no interface impedance developed with tubes whose cathode base material contained less than 0.01 per cent silicon.

The interface impedance is not a simple lumped-constant network, but a distributed-constant element. Bridge measurements have shown conclusively that a network with at least four elements is necessary to give a second-order approximation to the interface impedance for a given operating condition. Such a network commonly has two open-circuit time constants between 0.1 and 10 microseconds. It has been found that the interface impedance is nonlinear. The impedance depends largely on cathode temperature (heater voltage), operating conditions (both the level of cathode current and the electrode potentials necessary to obtain the current), and time of current flow, especially the first second or so of operation after a cutoff period.

Progress in Communication

DURING the last months of 1953 and the first few weeks of 1954, four important steps in the progress of electrical communication were announced in quick succession. On November 17, a radio message which flashed from a giant antenna strung across a deep valley in the Cascade Mountains of the state of Washington circled the world to bring all of the far-flung elements of the United States Navy within direct and instant reach of their homeland. In December, the Bell System announced that plans had been completed and work was soon to begin on the construction of a 2,000-mile, underwater, coaxial cable between Nova Scotia and Oban, Scotland, which will provide 36 simultaneous telephone channels between New York and London. Successful recording, on magnetic tape, of television pictures in black and white, as well as in colors, was announced by the Radio Corporation of America shortly thereafter in a development that inaugurates an era of electronic photography, and makes possible the transcription of picture signals for later reproduction without the need of photographic processing. But perhaps the development that will most readily capture public fancy is the announcement, by the Federal Communications Commission, that a compatible system of color television has been approved for commercial use, as a result of industry-wide co-operation in the creation of the necessary standards. It is expected that production models of the first color television receivers should make their appearance about the middle of 1954.

Each of these developments is of major significance, and each has taken anywhere from one to 25 years to bring to fruition. Yet, so accustomed have we become to announcements of significant developments based on science that public comment on such news may be said to be almost conspicuous by its absence.

The Navy's radiotelegraph transmitter at Jim Creek Valley, 55 miles northeast of Seattle with a power rating of 1,200 kilowatts, is the most powerful radio transmitter ever built. This $14,000,000 project took six years to complete and is intended to provide direct and instant communication to naval units in all parts of the world. It operates at the low radio frequencies of 14.5 to 35 kilocycles per second. Most spectacular portion of this high-power station is the antenna system. Ten catenaries, supported by 12 towers each 200 feet high and built along the crests of the ridges 2,700 feet above the floor of the valley, support the zigzag spans, the largest of which is 8,700 feet in length. The antenna, as well as the transmitter, is divided into two units, each half of which may be operated separately and independently. It is interesting to learn that only six minutes elapsed from the time the inauguration message was tapped out at Jim Creek until replies commenced to pour in from naval units in all parts of the world.

A quarter of a century of development – on the part of engineers of the American Telephone and Telegraph Company in the United States and of the British Post Office in England – underlies the technological foundation that will make the fabrication and laying of the transatlantic telephone cable a reality within

a few years. The project, which will cost $35,000,000, is a joint undertaking of the American Telephone and Telegraph Company, the Canadian Overseas Telecommunication Corporation, and the British Post Office. The cable will provide direct telephone communication between New York and London by means of landline from New York to Portland, Maine, microwave radio relay from Portland to Nova Scotia; underwater cable from Nova Scotia to Newfoundland; deep-sea cable from Novia Scotia to Oban, Scotland; and landline circuits from Oban to London. The cable will handle 36 simultaneous conversations, thereby tripling existing radio-telephone circuit capacity. The facilities will be adequate for radio program (music) applications, but will not be adequate for the transmission of television signals.

The deep-sea cable between Nova Scotia and Scotland will employ 100 vacuum tube repeater amplifiers. In each repeater station, which will be one and a half inches in diameter and seven feet long, will be three vacuum tubes. Power for the amplifiers will be carried over coaxial conductors. A major problem in the design of the cable was to develop electron tubes with sufficient reliability as to last years without replacement, and to provide means for by-passing tubes that might fail in service.

The magnetic tape recording of television pictures is expected to play an important role in commercial broadcasting of color television programs. Since no chemical processing is required, the programs may be reproduced as soon as they are recorded, and programs from tape which has served its purpose may be readily erased so that the same tape can be used over and over. In principle, the recording of television signals on magnetic tape is the same as that used for tape recording of sound. However, whereas sound frequencies range from 20 to 20,000 cycles per second, signals for television use must operate up to frequencies at least as high as 4,000,000 cycles per second. Accordingly, it is necessary to increase the speed at which the tape travels from 15 inches per second (the speed used in sound recording) to 30 feet per second; moreover, the speed at which the tape travels must be maintained extremely constant, at both the recording and the reproducing stations.

Radio Corporation of America

W. D. Houghton (left) and Harry F. Olson operating the laboratory equipment on which the first public demonstration of tape recording of both monochrome and color television was made. Messrs. Houghton and Olson head R.C.A.'s seven-man research team which is working toward simple and economical methods of reproducing motion pictures for television broadcasting and home entertainment. The last two racks on the right, in the illustration, are for test purposes and not part of the video tape recorder.

In the initial demonstration, five parallel channels were recorded simultaneously on a half-inch tape. One channel was for sound; one channel was used for each of the three primary colors (red, green, and blue) into which the images were resolved; and the fifth channel was used for synchronizing purposes. Black-and-white television signals can be reproduced on a tape one-quarter inch wide, with but two channels; one for the video signal and one for the audio.

Magnetic tape recording stores the electrical signals directly as they come from the television camera, and neither electronic nor photographic processing is required. Copies can be made for distribution at a cost of $15 per copy for a half-hour, black-and-white program, provided the tape is reused many times. Copies of color television programs can be made at a cost of approximately $20 for a half-hour program. Of course, these figures refer to the cost of recording visual images on tape, and not to the cost of producing the original television programs.

The action of the Federal Communications Commission in approving a "compatible" system of color transmission not only opens up the era of commercial color television, but assures televiewers that they will be able to receive program material from either black and white or color television transmissions. Under the compatible system of television standards, existing television sets can receive color programs in black and white without any changes or additional accessories, whereas the new color television receivers to be built, beginning this year, will be able to receive either color or black-and-white television programs. Of course new color television receivers will be required to utilize full color programs, for the necessary additional circuits and color kinescopes can hardly be added as accessory equipment to existing receivers. By establishing television transmission standards which are compatible, the industry is assured that there will be markets for both black and white as well as color transmissions for many years; furthermore, set owners need not fear sudden obsolescence of their receivers as the result of the introduction of color transmissions.

These, and similar, developments inaugurate new landmarks in the progress of electrical communication; the celebrations which accompanied the opening of each of these new services are tributes, even if silent ones, to those engineers, scientists, administrators, and financiers who have made possible such technological progress. And now that we have such remarkable facilities for communicating ideas, wouldn't it be worth while to examine the quality and intellectual merit of the ideas we have to communicate over these new instrumentalities?

The University and the Community

Universities Have Developed a Whole New Relationship with Agriculture, Industry, Management and Labor That Can Materially Benefit Their Communities

By JAMES R. KILLIAN, JR.

The Review is pleased to present to its readers the text of Dr. Killian's address which was delivered at the inauguration of the Graduate School of Arts and Sciences of Brandeis University. Dr. Killian was the principal speaker at the ceremonies which were held on January 14, 1954.

IN behalf of its sister universities, I have the honor of congratulating Brandeis University on the inauguration of its Graduate School of Arts and Sciences and of conveying to you and your associates, President [Abram L.] Sachar, the pleasure we all feel in your progress and in your prospects.

On other occasions I have spoken of the good neighbor policy which prevails among institutions in Greater Boston. Good neighbors welcome *new* good neighbors, and so we delight to see a new graduate school augment the scholarly resources of this community. I like to think of our universities, hospitals, and research organizations as creating together a University of Greater Boston, an entity which is greater than the sum of its parts and which is the more effective because it has no corporate existence except the powerful sense of commonwealth to be found in groups of scholars spontaneously interested in each other's work. Such a spirit pervades this community. A distinguished British scholar, Jacob Bronowski [Carnegie Visiting Professor of History at M.I.T.], recently spent several months in this community, and when he returned to England, he wrote in the London *Observer* that he had never spent so many stimulating evenings with first-rate men "excitedly talking each other's shop." What the biologist calls the "fecundity of aggregates" in speaking of living cells also applies to institutions and groups of scholars. Our commonwealth grows stronger, our scholarship more fecund, through the presence of this vigorous new institution.

An occasion such as this brings other sentiments of satisfaction and anticipation.

Society has invented the university to perpetuate itself and "to create its future." Practical planning and prudence thus motivate the founding and building of a university. But there is something more. The building of a noble university is an expression of the generous impulses, the high purposes, and the soaring aspirations of a free society. The university serves the present but it does this better if it preoccupies itself with the possibilities of the future.

These practical and altruistic aims have been exemplified in the building of Brandeis and in the forming of the graduate school we inaugurate tonight. You who have founded and are building this new institution should sense and savor the event taking place. Once it is successfully delivered, a university has a greater life expectancy than almost any other human institution. We can consequently sense the long reach of this occasion by anticipating how some future historian of Brandeis will laboriously reconstruct out of antiquity some measure of the temerity, the sweat, and the prescience which characterize the founding of Brandeis – and its founders.

Formal graduate study in the English-speaking world has developed largely in the span of one generation. In 1870 there were less than 50 graduate students in America. Today they number over 80,000. In his *Unforgotten Years,** Logan Pearsall Smith recalls how research was viewed with suspicion and contempt at Oxford University in the 1880's. Benjamin Jowett, the redoubtable master of Balliol College and founder of its tutorial system, described research as a "mere excuse for idleness; it has never achieved, and will never achieve, any results of the slightest value." When Smith challenged this statement, Jowett demanded an example. Smith could only recall the then recent discovery that a tap on the kneecap would cause the patient to give an involuntary kick, and that this provided one piece of evidence of his neurological health.

"I don't believe a word of it," said Jowett. "Just give my knee a tap."

Smith obliged, whereupon the professorial leg reacted with a vigor which surprised Smith and astonished Jowett.

This involuntary jerk of Jowett's academic leg symbolically kicked open the door to a new era of advanced education. Already in Germany and the United States, as indeed it had in England, graduate study had taken root in the universities. The universities were quick to demonstrate that they had special advantages for the conduct of research, and that research was an essential technique of advanced education. We sometimes forget that the university was not always the habitat of basic research, and we might well remember that it could move into other kinds of institutions if universities ceased to be a favorable environment for it.

An academic cynic, thinking perhaps of Jowett and his times, once remarked that in a university, "nothing must ever be done for the first time." You of Brandeis who are doing something for the first time

* Boston: Little, Brown and Company, 1939.

Ward Allan Howe

Our universities are important partners of management and labor in maintaining a vigorous economy.

every day must have a joyous sense of the free and open road. We who know something of the built-in obduracy of older institutions can but envy you the happy state of having so little of the past to obstruct and complicate the future. Perhaps this explains Gilman's great achievement in starting American graduate study when he started Johns Hopkins, but it should also be added that no institution with a powerful graduate school can easily remain static and tradition-bound.

With these sentiments, anticipations, and good wishes, I hail your new graduate school and express the neighborly hope that it will prosper.

In the context of the Twentieth Century, our universities have assumed new duties and responsibilities unknown to them a generation ago. Today they are being asked to serve the nation, their states, and their communities with a range of services that removes them decisively from the role of ivory towers, insulated from reality. Let me be specific.

Prior to World War II, universities had done a negligible amount of research for the federal government. During the war the largest military and weapons research laboratory ever essembled – a laboratory in this area – was managed by an educational institution. The great atomic bomb laboratory at Los Alamos was, and still is, managed by a university, and at the present time many of the nation's major research laboratories and projects are handled by universities.

The impact of the cold war has made it necessary to mobilize our scholarly resources so that we may better understand Communism and counter its threat. University research centers of many kinds, especially those devoted to international affairs, have been called upon by the nation to help, and have been making significant contributions. Scholars, organized by the universities in this area, have played an important part in fighting Communism.

Our universities have developed a whole new relationship with agriculture, industry, management, and labor. Experiment stations aid the farmer and the small company, scientific and engineering faculty members serve as consultants to industry, the medical and public-health schools work directly with community public health agencies and hospitals. Faculties of law, business, and education are closely articulated with actual practice in their fields. The social scientist, the architectural professor, and the planner are in great demand as advisers to government and to all manner of community activities.

In one institution in this community, an estimate has shown that faculty members, on the average, spend a quarter of their time in activities of a public-service kind and for which neither they nor their institution receive any compensation. This means a contribution to the public service by this one institution of about $1,000,000 a year in salaries paid. Multiply this in proper proportion by all the institutions in this area, and you begin to get a measure of this total public service. This kind of service is a part of the responsibility of the modern American university.

The university's new responsibilities for national and community service have been recently documented in a study conducted by the New York State Citizens Council. As summarized by Benjamin Fine of the New York *Times*, this study identified four methods whereby colleges and communities achieve a mutually productive co-operation. These are:

(1) Use by the college of the skills, abilities and education of persons within the community for the purpose of enriching the educational process.

(2) Use by the college of the community as a laboratory for the purpose of advancing the educational process.

(3) Initiation by the college of various community undertakings in which the college functions merely as one of many agencies within the community.

(4) Development by college and community of mutually beneficial undertakings.

This kind of co-operation is obviously a two-way street. Certainly the university finds this new relationship productive, and as a result the scholar comes to have a heightened sense of his usefulness.

With this new range of university-community relations in mind, I venture next to offer a close-up of the ways our local institutions benefit the economic life of this community. Lest this seem to be a narrowly provincial view to our guests from other parts of the country, I hasten to make clear that I know that similar claims can be made for other sections for their institutions. I also parochially limit my examination to science and technology, since I know these fields best. My other excuse is that Brandeis is also celebrating a large gift for a new science building.

I submit that in New England, in Massachusetts, and in Metropolitan Boston, our universities are important partners of management and labor in maintaining a vigorous economy. Out of the universities are coming directly new products, new industries, new wealth. Through research, the universities are helping this region to replace lost industry by using advanced technology and know-how to create new industry. They also help existing industry achieve new products and new efficiency both in technology and in management.

They supply well-educated individuals with entrepreneurial interests who understand the arts of management, the use of research and new knowledge. They are the sources of the raw material of ideas and they are stockpiles of information.

Let me give some case histories by looking first at Brandeis' own home, the Waltham-Watertown area. Among its many growing companies is the Raytheon Manufacturing Company which employs about 18,000 people in the state. One of the founders of Raytheon was a professor and a dean of engineering educated at Tufts and at M.I.T. This same man directed the greatest war research program in history. His name: Vannevar Bush, '16. During World War II, when we were struggling to develop adequate radar, Raytheon, working in partnership with an educational institution, made a major contribution, and as a consequence stands today as one of the industrial leaders in this field.

Or take another example, the Barry Corporation, which has been created since World War II and which now does a business of over $5,000,000 a year. The founders of the company, and the product upon which it is built, both came out of a nearby wartime university research laboratory.

Let us look next at my home city, Cambridge. Radcliffe, Harvard, and M.I.T. together form the city's largest employer of people with a total on their payrolls of nearly 14,000. The combined annual payroll of these three institutions is more than $35,000,000. Their combined annual expenditures are $85,000,000. This past year they had under construction new facilities totaling $10,000,000. Much of the new money is drawn from outside the state. I estimate that two thirds of the total capital resources of M.I.T. were attracted from outside Massachusetts. To put it one way, our local institutions import money and men and export ideas. For example, the recently established National Science Foundation Fellowships point up the drawing power of our local institutions. These fellowships, awarded to young scientists all over the nation, permit their recipients to study where they choose. More than 20 per cent of them have elected to study in Greater Boston; and I am pleased that my own institution draws the largest number of any institution in the country.

Let us look next at Metropolitan Boston. In the past four years its educational institutions have been the major factor in the location here of government electronic research facilities costing $11,000,000 and employing 2,000 men and women. The research resources of these institutions helped also in attracting here the new Quartermaster Research Laboratory. During World War II a local college had the responsibility for one of the major scientific efforts of the war and for the expenditure of $125,000,000 for research. At the present time, institutions of Greater Boston have mobilized hundreds of scientists who are working unselfishly, quietly, and patriotically to give the nation stronger defenses at lower cost. Greater Boston has become one of the nation's largest, and most important, research centers for defense research.

Finally, let us look at the universities as an all-New England resource.

In a recent survey of 41,000 American scientists, 14 per cent were shown to have received their Ph.D. degrees in New England and 12.5 per cent their bachelor's degrees. Since only 6.3 per cent of the population of the country resides in New England, these are impressive proportions. They reflect the importance of our graduate schools and the research they undertake. The excellence of the region in the scientific personnel it attracts and maintains is shown in its share of the total members of the nation's top scientific society. Twenty-one per cent of the members of the National Academy of Sciences work in New England, and of these, over 90 per cent are in the region's colleges and universities.

In this high concentration of scientific talent, we find one of the reasons why in 1950, New England institutions were responsible for nearly one third of all the research undertaken by colleges and universities for the military services.

As reported in the Boston *Herald* of Sunday, January 10, in New England "the Air Force has awarded research contracts worth about eighty-two million

Raymond E. Hanson

. . . the evidence is clear that New England is witnessing a new industrial revolution, and that its universities have played a part in furthering it . . . . it is important that we encourage and further develop this fruitful relationship.

dollars. 'New England,' an Air Force officer said, 'seems to have become our most important development area in the country.' "

As the report of The Committee of New England recently pointed out, this region possesses at least 46 colleges and universities that furnish technical training and operate research laboratories. These institutions have been responsible, at least in part, for the location in New England of many new companies. As this report points out, "During the last few years, a whole new generation of research-based new enterprises has come into existence, frequently to exploit new scientific and engineering knowledge acquired during World War II. A large number of such companies have settled and grown near their spawning ground in Cambridge . . ." By spawning ground is meant what I have already described as the University of Greater Boston as well as the research institutions along the Charles River. This is one of the greatest concentrations of scientific, engineering, and research talent in the world. In any terms, this concentration of research is a community, a state, a regional, and a national resource of the first magnitude.

Let me turn next to another recent report, *A Survey of Industrial Opportunities in New England*, by Arthur D. Little, Inc. "The high quality of research in New England," notes this report, "has concentrated an increasing number of new firms around its research centers . . . One of the unique assets for the machinery industry in New England is the concentration of technological knowledge in universities and private research corporations . . . [university] and research laboratories in the Boston area are the hub of electronics developments."

And so these reports document my thesis. We have only to look at the new lexicon of corporate names in this area to see the impact of university scientific research and high technology: High Voltage, Inc.; Tracerlab, Inc.; Photon, Inc.; Polaroid; National Research Corporation; Ultrasonics, Inc.; Ionics, Inc.

I think the evidence is clear that New England is witnessing a new industrial revolution, and that its universities have played a part in furthering it. They should receive no special credit for doing so, for this is part of their public responsibility, but it is important that we encourage and further develop this fruitful relationship.

With these resources and these trends at work, it is important that we not sell New England short. For the same reason our New England colleges and universities should not be sold short. In the furtherance of New England's welfare, our universities, together with the other great agencies of the region, can make an increasing contribution to the economic stability and the prosperity of the region.

The biologists have a scientific term which they use to describe the habitual living together, or interdependence, of organisms of different species. This term is symbiosis, and it is applied to a relationship that is beneficial to both organisms and harmful to none. I suggest that our universities and our communities stand in a symbiotic relationship to each other, each contributing to the strength and welfare of the other.

Certainly it is true that New England has provided a benign environment for higher education. It is unthinkable that it would not do so in the future, but we must always be alert to maintain the beneficent relationship which I have been describing. We must never allow our institutions or our community to find themselves at a disadvantage in attracting and holding first-rate minds.

New England universities have grown and flourished because their roots are in fertile soil. They have attracted and held first-rate teachers and creative scholars because these men found the environment here one of freedom, dignity, and benignity. Under these conditions there could be a confluence of all those subtle and impalpable factors which enable a group of scholars to make a great university where otherwise they might constitute a mediocre one.

We as citizens, and we as educators, ought never to underestimate the importance of this spirit, this climate, this priceless ingredient of a great university and a great community. This ingredient becomes inert in an atmosphere of suspicion, suppression, or long-sustained tension. It flourishes when there is mutual confidence and a sense of all-pervading integrity. It rests upon a ready acceptance of the duties of enlightened and responsible citizenship. It rests upon tolerance and freedom and forthrightness.

This kind of relationship between the scholar and the community has been traditional in this region. If we can maintain it unimpaired, our community, universities, and nation will profit and grow in greatness.

In stressing the economic impact of our educational institutions, I have been dealing with a by-product of education. The prime and overriding responsibility of educational institutions is to *educate* — to advance our understanding of ourselves and to extend the reach of the human spirit. The university cannot serve the community or the economy effectively unless it does these *first* things well. Let me conclude by reiterating my conviction that the university must seek to exemplify the good, the true, and the beautiful if it is to do these other things well. Any report card on the universities must carry marks showing deficiencies and failures, but it is my observation that these deficiencies and failures are more in execution than they are in aims and aspirations.

Robert Louis Stevenson once spoke of his grandfather, the great civil engineer, as having used a "transcendental coefficient" in the design of all his great structures. This enabled him to build into them an exceptional measure of beauty and permanence along with their usefulness.

Our universities must have some such transcendental coefficient implicit in their design. They can never be great institutions by being merely utilitarian. A great faculty has competent teachers, brilliant scholars, creative specialists. But it has something more. It has men and women who teach with zest, dedication, and art. It finds and encourages men and women who have the rare temperament and personality that emanates goodness and wisdom. The teacher, the scholar, and the researcher should be dedicated men — men committed to the ideal aims of mind and spirit. They should be committed to the highest ethical and moral standards of our society. Their university must be the embodiment of the first-rate in all these things.

(*Concluded on page 262*)

The present critical situation of the teaching profession is a matter of grave concern to far-sighted individuals and organizations, as has been reported in the pages of The Review as recently as last month. (See "Science in High Schools," February, 1954, page 187.)

The Institute's Administration is keenly alert to the need for developing effective teachers. Since 1949, under a program of Westinghouse fellowships, M.I.T. has offered courses of instruction to approximately 50 science high school teachers who wish to improve their professional proficiency and become more familiar with the latest progress in the physical and the biological sciences. In addition, in a joint program with Harvard University, M.I.T. now offers a five-year program for those who wish to follow careers in science teaching. In this program, students receive their science training at M.I.T. and their pedagogical training at Harvard.

But the inspiration and stimulation which today's professors can instill in their students are probably the greatest contributions that can be made to the training of science teachers — as well as to scientists and engineers. It is a source of gratification, therefore, to learn the esteem with which one of Boston's newspapers regards the Institute's teaching. The following article by a staff writer of The Christian Science Monitor *was printed on December 23, 1953, and is reprinted in full (along with two of the* Monitor's *photographs) with the permission of that newspaper. — Ed.*

Professor Makes Physics Fabulous at M.I.T.

"Outstanding teaching being done in the Greater Boston area" discussed by Boston newspaper recognizing teacher shortage

By MARY HANDY

"He's really fabulous," the freshman whispered, pointing at his physics professor. As he spoke the whole lecture hall at the Massachusetts Institute of Technology exploded in a roar of laughter. Four hundred of the nation's promising young natural-scientists-to-be doubled up with mirth.

Their laughter was applause for one of the most popular MIT professors — and a man whose approach to teaching would be outstanding anywhere.

Dr. Hans Mueller, beloved by Tech students and graduates, was in the midst of a virtuoso performance.

Wildly swinging his arms he was forcing his body around, on the revolving platform on which he stood. His purpose: to illustrate the time-honored law of conservation of momentum. He was making it real, and vivid, even funny — so that his students, years hence, would remember it.

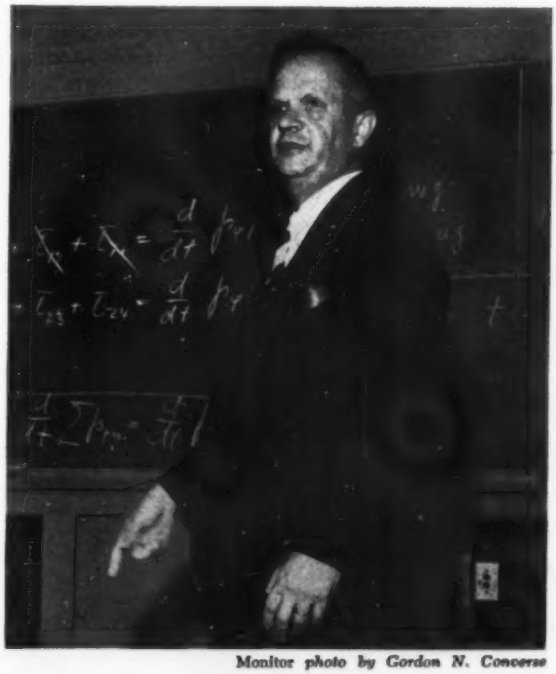
Like Dropping a Cat

"It's the same thing when you drop a cat," he called out in his marked Swiss accent. "If you drop a cat upside down it will land on its feet. Why? The tail. It will use its tail to swing itself over the same way I am driving myself around with my arms."

He rushed to the blackboard and chalked up a ridiculous picture of a cat upside down. Then, as the laughter subsided, he continued with equations.

This is all in a day's work for Dr. Mueller. All part of his conviction that teachers must put more of themselves into their classroom performance. Part of his conviction that physics, instead of being dull and hard, can be made tremendously alive through a more theatrical presentation.

"I'm a ham actor — and it's hard work," he explains, laughing.



Monitor photo by Gordon N. Converse

Hans Mueller

. . . Professor of Physics, covers the blackboards in Huntington Hall during a physics lecture to Technology freshmen.

Physics Workout

A physics lecture, Dr. Mueller's definition, includes: filling the 40-foot blackboard with equations at what seems breakneck speed to an outsider; jumping back and forth as he uses the experimental equip-

ment; speaking seriously to the front row of students to emphasize a point; running back to the board and writing up a new set of equations; laughing with his pupils as one of his planned jokes succeeds.

After his 50-minute performance – con brio and staccato – after the 400 students had pushed and flocked out into the corridors, Dr. Mueller chuckled.

"I told them a cat rights itself in the air by using its tail. You wait. Somebody's going to come and ask me about a bob cat." He was enjoying the class as much as his students.

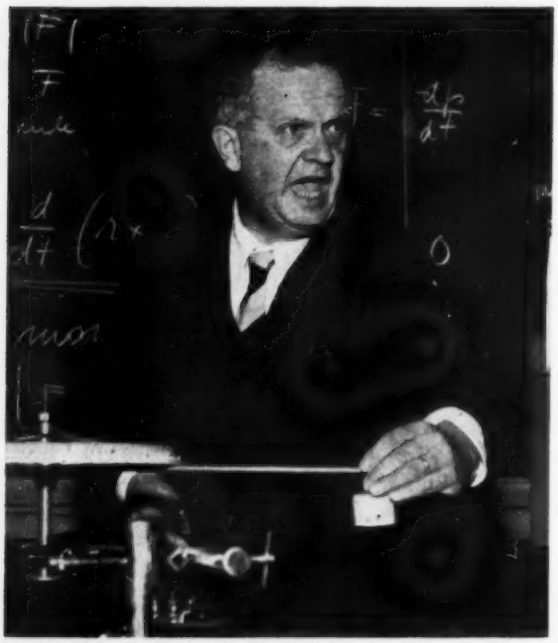
Job Seen as Challenge

Later, in his office, where desks are piled high with manuscripts of the new book he is writing, Dr. Mueller discussed his challenge as director of freshman physics at this world-renowned technical institute.

"This is a selected crowd here at M.I.T. Fifteen years from now these boys will, in substantial measure, decide America's industrial and technical development."

Dr. Mueller is a Swiss farmer's son. Soon after completing his studies at the Swiss Institute of Technology he came to the United States. He has been at M.I.T. for 28 years. But in his spare time and during summers, he and his wife and daughter live on a little farm in Massachusetts.

At the Institute he has taught most of the undergraduate and many of the graduate physics courses. He is well-known among natural scientists for his work in the field of optics. Recently, by his own choice he has taken charge of the freshman physics course. Practically every student who enters M.I.T. takes physics – making it a kind of introduction to the level of work M.I.T. expects.



Monitor *photo by Gordon N. Converse*

Demonstration, as well as mathematics, by Professor Mueller forms part of instruction in freshman physics at M.I.T.

Foundation Sought

"As they arrive here we want to give these boys a foundation of three centuries of philosophy of science. The technical applications are not important at the beginning. We want to keep an awakened interest in the basic principles," he says.

"It's not the amount we teach these boys that matters – it's the thoroughness. It is more important for a man to understand thoroughly what he has learned, than to try to grasp a great deal poorly. We must teach these boys to walk before we teach them to dance."

As director of freshman physics, Dr. Mueller keeps his door wide open to all first-year students. They flock to him with problems ranging from mathematical formulas to loneliness.

"There's a lot of tension among freshmen today. We try to relieve it by giving more and more personal attention." It is plain that his kindness and genuine interest have helped many a student over a rough spot.

Experience Held Vital

Nor is he critical of slow learners. "Boys grow up at different rates. Sometimes the slow freshmen remember the most. You need tremendous experience to help each boy in his own individual way."

As for his theatrical presentations, they are all purposefully worked out. "We teachers must create enthusiasm. The only way is to be enthusiastic yourself. I have to live it all through with them."

And Dr. Mueller does "live it all through" with his students to an exceptional degree. He companions them in their enthusiasms both in and out of class.

During the recent presidential campaign when Tech boys were actively putting forward the comic-strip possum, Pogo, as their candidate, Dr. Mueller, too, wore a Pogo button under his lapel.

He recognizes teaching as one of the most important influences on young persons. He remembers how deeply his professors at the Swiss Institute of Technology influenced his own career.

Recalls Own Teachers

Vividly he tells of eating dinner with three professors all of whom since have won Nobel prizes. These men were physicists. It was what they said to each other at the dinner table, and what they said to him as an eager, young student that influenced him to become a physicist.

"One of them related how the laws of physics and mathematics had seemed a revelation," Dr. Mueller relates. "Another talked of the practical applications of physics. He said he was fascinated with being a physicist because through inventions it makes things easier for people.

"And the third simply said he got an awful lot of fun and kick out of it."

The interest that these professors showed in him and their obvious satisfaction from physics led Dr. Mueller to follow their example.

"It's an adventure," he says. "Even after 28 years of teaching I keep experimenting all the time."

Mining and Mineral Deposits
IN NEW ENGLAND

By CARLE R. HAYWARD

MINING Engineering, as indicated by its designation – Course III – was one of the earliest courses established at M.I.T. When it was dropped from the curriculum in 1940, one of the arguments for the action was "Why teach mining in New England where there are no mines?" It is true that few mines are at present operating in New England and it is not the purpose of this paper to argue regarding the wisdom of dropping the Mining Course, although the action came as a shock to many of the older Alumni. The bibliography at the end of this article (page 274) will show, however, that there have been an astonishing number of mining operations in this area, some mere prospects and others of considerable size which have attracted attention and stimulated investment from colonial times to the present day. The writer, a graduate of old Course III, is presenting herewith a summary of the information given in these references together with some personal comments.

New England may be classed as a "ghost" mining camp but there are some spots which felt for a brief period the thrills of a mining boom. Although it must be admitted that most of the operations did not prove to be profitable, it is a matter of record that mines in New England have been opened on mineral deposits containing the following metals: gold, silver, iron, copper, lead, zinc, nickel, tin, antimony, beryllium, bismuth, cadmium, chromium, cobalt, calcium, magnesium, manganese, molybdenum, titanium, and tungsten. It is doubtful if any other area of similar size in the United States has produced 20 metals.

Coal, graphite and sulfur have also been produced in New England and such nonmetallic minerals as asbestos, mica, feldspar, and garnet. In addition to these, the allied operations of quarrying granite, marble, and slate have been profitably carried out in many localities. Up to 1870, Vermont led the states as a producer of copper and in the early days of the Nineteenth Century Connecticut was fourth as a producer of iron.

In view of the above facts it is not surprising that a Course in Mining Engineering was established at M.I.T. Many graduates of this Course have had distinguished careers.

One of the most important figures in the early mining history of New England was John Winthrop, Jr., son of the governor of Massachusetts Bay. He went to England in 1641 and enlisted help to form the "Company of Undertakers for the Iron Works in New England." In 1643 he returned with an initial capital subscription of 1,000 pounds, tools, and workmen. Included in the latter were Joseph Jenks who became chief engineer of the iron works at Saugus, and Henry and James Leonard who developed the Taunton Iron Works. Winthrop later went to Connecticut and in due time became governor of that colony. He received grants for the development of several mining properties in Connecticut and the graphite mines in Sturbridge, just across the border in Massachusetts.

Most of the early mining operations in New England were confined to excavating the bog iron ore from the numerous localities where it was found, and hauling it to the forges and bloomeries where it was reduced to semifused masses of crude metallic iron which were later hammered into useful articles. Later, purer forms of iron ore were mined and smelted in blast furnaces with charcoal fuel to form molten pig iron used for castings. As time went on, veins containing numerous other metallic minerals were found whose development required hard-rock mining. The ore was then treated in various ways to produce the different metals.

Although the mining and treatment of these minerals might well be discussed under the separate headings of the metals concerned, it will probably avoid confusion if the operations in the six New England states be taken in order, with mention of the different mining activities which have been recorded within the borders of each. This plan will therefore be followed in this article.

Maine

Mining operations in Maine were of little importance until about the middle of the Nineteenth Century. A few bloomery forges, operating on bog iron ore, are recorded in York County during and immediately following the American Revolution but the first operations of any importance were a small iron blast furnace at Shapleigh, York County, in 1846, and the Katahdin Iron Works built in the same year in Piscataquis County. The Katahdin works produced 2,000 to 15,000 tons per year until it closed in 1890. These two furnaces used the iron minerals, magnetite and limonite, which have fewer impurities than bog ore; the product was pig iron instead of blooms.

Considerable iron ore, high in manganese, exists in Aroostook County but it is interesting as a possible future source of manganese rather than as an iron ore. This deposit has recently been studied by the U.S. Bureau of Mines but no economical method for extracting the manganese has yet been found.

Lead ore – containing also copper, zinc, gold, and silver – was found near Lubec, Washington County, in 1832. The property was worked a short time, then shut down. In the early 1870's it was reopened for a short time and operated by more improved methods but finally was abandoned.

Maine experienced a mining boom, beginning in 1879, which lasted about two years. A graphic account

is given* by Virginia Chase Perkins. Several prospects showing copper, lead, and zinc, containing varying amounts of gold and silver had been opened along the Maine coast from Blue Hill to Calais. In 1879 a man named William Stewart, a native of Maine who had gone to California in the gold rush days, returned to Maine and naturally visited some of the mining prospects in Acton, Hampton, Sullivan, Franklin, and Hancock. In a report on these districts he stated: "By merest accident I floated into mining regions of Eastern Maine and after fatiguing exploration of several of the most important mining districts in the counties of Penobscot and Hancock I am prepared to assert that this is of a verity a promising silver-bearing region. I can assure you that I have recently examined mines which for fertility of silver will compare favorably with first class mining properties in Colorado and Nevada."

Less than eight weeks after Stewart's report was published, 600 men were employed at Blue Hill, 550 at Acton, and 1,000 in the Sullivan district. The latter produced considerable excitement because of the high silver content of the ores there. The deposit was discovered in 1877 and showed minerals of lead, zinc, and copper which carried much of the silver, although some metallic silver was also found. The value of the ore averaged about $100 per ton. Several shafts were excavated on the property, one of which was 190 feet in depth. Fifty companies were incorporated in this general area with a total capital of $25,000,000.

The wide interest taken in the mining operations in Maine is indicated by the following quotation copied from *Mines of Maine* written by F. L. Bartlett, State Assayer for Maine.[23]

It is safe to say that not one in fifty of the readers of the Herald has anything like an accurate idea of the discoveries which have been made, the work which has been done and the bright prospects of the future which exist in eastern Maine. – **Boston *Herald*.**

We have personally visited Sullivan and feel sure that the correspondent of the Boston Herald does not overrate the value of these extraordinary eastern silver mines. – **From an editorial in *Mining Record*, New York.**

Maine has been settled so many years and been accessible, that to assert that it possesses gold, silver and copper mines which promise in the not very remote future to prove sources of wealth greater than all its other industries, is to invite disbelief and ridicule yet we believe such to be the fact. – ***The Economist*, Boston.**

If mineral veins like these had been discovered in some remote new district in Colorado, in six months' time a settlement of some five or ten thousand people would have sprung up full of speculators and miners. – **Editorial, New York *Tribune*.**

The Wall Street News, Boston Advertiser, Chicago Mining Journal, Portland Transcript and many other leading papers commented on the mining industry in Maine as being of good promise and predicted favorable results.

Bartlett states: "Mining men of great and varied experience from the oldest mining districts of the Pacific coast have come and settled in our midst and are showing their honest belief in the value of our mineral deposits by spending their time and money in developing them." Bartlett also quotes W. F. Stewart of Virginia City, Nev., as follows: "The developments made during the past three years in the various mining locations at the Blue Hill district furnish indubitable assurance that the owners of those properties are on the verge of realizing priceless bonanzas of precious and useful metals."

The *Mining Journal* began publication in Bangor and reported on the excitement in the mineralized districts. At Scurry the inhabitants were said to scan with eagle eye every ledge and crevice. At Isle au Haut every man and boy had his pockets filled with rocks. At South Waldoboro wonderful discoveries were reported daily. At Round Pond the women were leaving their kitchens to go prospecting. All over the lower part of the state, property owners blasted ledges and formed mining companies without waiting to learn the results of assays. Farms sold for exorbitant prices. Men came to Maine mines from all over the United States and even from Wales, Cornwall, and Sweden. By April, 1880, there were 123 incorpo-

* For numbered references please see Bibliography at end of article, page 274.

Richard Merrill

Through the courtesy of the First Iron Works Association, restoration work now in progress is illustrated, which shows partly restored furnace at back center and overshot type of water wheel at right. This wheel, which furnished power for the furnace bellows and for other purposes, was recovered in a fair state of preservation after remaining buried for more than 200 years.

rated companies and 48 privately owned. Some of the companies equipped their mines elaborately with little basis for the expenditures.

The most important property in the region was the Douglas Mine at Blue Hill, the richest copper mine in the state. The management spent nearly $12,000 in 1878 and their operations attracted wide attention. The water front was busy, and since the mine was close to the harbor, excursion steamers from various coastal cities brought numerous sight-seers. The sulfide ore produced was roasted in heaps near the mine with evolution of clouds of sulfur dioxide gas. The product from roasting was then smelted to produce copper.

The mines of Maine produced about 5,000 ounces of silver during the boom. The crash began in April, 1880, and in 1881 only 35 mines remained in operation. In May, 1883, the Douglas Mine was the only property being worked and in August, 1888, it was sold at auction for $75,000 but not reopened. From 1878 to 1883 it had produced about 2,000,000 pounds of copper valued at about $300,000.

In 1917 when copper prices were unusually high, due to World War I, the American Smelting and Refining Company took over the Douglas Mine, installed modern concentrating machinery for treating the ore, and shipped the concentrates to Perth Amboy, N. J., but this operation stopped when the price of copper fell at the close of the war. In 1948 the U. S. Bureau of Mines explored the property with diamond drills but no significant mineralization was found. It has been reported that a large sulfur company is investigating this property with a view to extracting the sulfur and recovering the copper as a by-product.

Another property which for a time seemed attractive was at Cape Rosier. The ore contained about 20 per cent zinc, 2.8 per cent copper, and some lead. About 10,000 tons were produced but the operations proved to be unprofitable. The property was explored with diamond drills in 1940–1941 by the St. Joseph Lead Company, and in 1942 by the U. S. Bureau of Mines but the results were not encouraging. The mine at Deer Isle is another of the group which contains sulfides of zinc, lead, and copper.

Maine has several properties where the mineral, molybdenite, is found. This is the sulfide mineral of molybdenum from which nearly all of that metal is produced. The most important deposit in Maine is at Catherine Hill in Hancock County and other deposits exist at Brunswick and at Crocker Hill but none is of great importance.

The mineral, beryl, which is the only important source of beryllium, is found in scattered points in Maine and is occasionally mined commercially though in small quantities. At Vanceboro, near the New Brunswick border, an antimony mine was operated in the early Nineteenth Century. Traces of nickel and cobalt have also been found in several places but not in sufficient quantity to stimulate mining.

In addition to the gold which is present in some of the sulfide veins previously discussed, placer gold has been recovered from the streams flowing into the Rangeley Lakes, from head waters of the Kennebec and from the head waters of the St. John River.

While these notes were being assembled, the May, 1953, number of *Engineering and Mining Journal* appeared with the story of finding a new ore deposit in New Brunswick. This district is an extension of the same geological structures as occur in Maine and the story of its discovery and exploitation sounds strangely like the discovery of the Maine deposits, as will be noted from the following extract from the *Engineering and Mining Journal* article.

Canada's Newest base metal show, most impressive of its kind in the past two decades, will probably change the mining history of a whole province.

It seems slated, also, to focus new public attention on the northern end of the Appalachian Shield; long known as host to a great store of mineral wealth, but neglected (except for the efforts of a few big companies) for a long time.

Time must elapse before its potential can be known. In the meantime it is clear that at least one major mine will be established; for Brunswick Mining and Smelting Corp., owner of the known deposit, has in six months outlined by drilling at least 30-million tons with gross value of considerable more than $750-million in zinc, lead, silver, tin, pyrite, and copper.

An open-pit mining operation is visualized with mill capacity of 5,000 tons daily. Profits, needless to say, should be substantial.

Seldom, even in mine-conscious Canada, has a new find fired public imagination to a similar extent. Though it's not yet four months since the news became known, New Brunswick has been the scene of an unprecedented staking rush. Some 30,000 claims have been staked in a frenzied surge that has spread through almost all parts of the province. There has been time yet for exploratory work on only a dozen or so properties; and the coming summer is sure to see a wave of prospecting, surveying, and drilling such as no Maritime province has ever witnessed.

The work will be well warranted. The prizes could be tremendous. The Brunswick mine alone could be big enough to raise New Brunswick a notch or two in its rank among the Canadian provinces. Last year its mineral output, mostly coal, was about $12 million, or not quite 1 per cent of the country's total. It's not difficult to visualize this one mine more than doubling that amount.

New Hampshire

Iron of sufficient quality to justify shipments to England was discovered near Portsmouth in 1634. In 1672 the Massachusetts General Court granted the town of Portsmouth, in return for a contribution to Harvard, a six-mile tract of land at the head waters of the Lamber Eel Run for an iron works.

From 1719 to 1735 bog iron ore was treated in several bloomeries, and in 1791 iron works were mentioned at Exeter. From 1795 to 1800 a furnace at Winchester smelted magnetite ore and in 1805 magnetite ore from Lisbon was smelted at Franconia. In 1808 the Haverhill and Franconia Manufacturing Company was incorporated and operated until 1865, using cold blast furnaces until 1844 and then furnaces using hot blast.

Small forges for treating bog ore have been mentioned as operating in Bath, Bradford, Concord, Deerfield, and Tamworth. Lead and zinc minerals are found at many places in New Hampshire.

A mine near Madison, Carroll County, containing a complex sulfide ore of copper, lead, and zinc was

discovered in 1826 and had an irregular history of production. Previous to 1840 a shaft was sunk on this property to a depth of 40 feet, and 15 barrels of picked lead ore were shipped to Baltimore. The vein was reported to be about six feet wide but sparsely mineralized with lead and zinc sulfides. The mine was closed for a time but reopened in 1870 and a mill was erected to concentrate the ore. A crew of 25 men was employed for a short time. During World War I the New Jersey Zinc Company operated the property for six months.

In 1846 a lead mine was opened at Shelburne, Coos County, and a shaft was sunk 275 feet deep. In addition to lead sulfide, there were sulfides of copper and zinc present. There was some rich ore but its occurrence was spotty.

The Warren Zinc Mine in Grafton County has had a succession of owners and several periods of operation since its discovery sometime previous to 1844. Between 1900 and 1904 the shaft was sunk to 400 feet on the incline, and in 1914 the depth was increased to 600 feet. This property still attracts attention in times of high metal prices.

Veins carrying copper sulfide occur in the Gardner Mountain section of Grafton County but the only copper mine of interest is the Milan Mine in Coos County. It was discovered in the early 1870's and was worked steadily until 1886 with a monthly output reaching 2,600 tons of ore. It was reopened for a brief period in 1895 and again from 1907 to 1910. In 1938 the property was acquired by Ventures, Ltd. of Canada. It was explored by diamond drilling in 1948.

Gold was discovered in New Hampshire in 1854 and in 1866 active gold-mining operations were being carried on near Lisbon, using stamp mills for crushing the ore. There is also some record of placer deposits. A total of $50,000 in gold was shipped to the United States mint over a short period of years.

The area near Keene has been an important producer of feldspar and mica, and some garnet of industrial quality has been produced in the state.

Vermont

Vermont, like the other New England states, had an early iron industry based on small deposits of bog ore mostly confined to the southern and western parts of the state. The first operations were reported in the vicinity of Bennington in 1775. Ore was mined in Rutland County prior to 1785. In 1794 there were 14 forges, 3 blast furnaces, and a slitting mill in the Rutland district. At the same time Bennington County reported one forge in operation; Addison County, four; and Chittenden County, two. At one time in the early Nineteenth Century there were 14 bloomeries in the neighborhood of Vergennes – all of which were built by Boston capital.

A deposit of hematite exists in Franklin County. This ore was smelted in a Catalan forge in 1835 at Sheldon. Similar veins were found at Enosburg and St. Albans. A steel works, using a 10-ton open-hearth furnace, was built at St. Albans in 1872. The charge for the furnace was pig iron, scrap, and iron ore.

In the early 1900's there were many small blast furnaces in the state producing pig iron from magnetite, hematite, and bog ore. Some of the old furnaces were still in existence a few years ago at East Pittsford, Plymouth, Forest Dale, and East Bennington. Manganese minerals were often associated with the iron ore. The ore at Wallingford was particularly high in manganese.

There is little lead and zinc in Vermont. Mineralized veins containing sulfides of these metals with some copper were discovered at Bridgewater and caused a brief flurry, but assays showed that the quantities were small. Other unimportant veins have been found at several points. Some placer gold has been found at Plymouth and several other points. It is estimated that the total recovery approximates $10,000.

Copper has been mined at the Elizabeth Mine near South Strafford, the Ely Mine at South Ely, and the nearby Pike Hill mine. The first was discovered in 1793, the second in 1821, and the third in 1860. These mines have had a separate history, and before the discovery of the large Lake Superior deposits in Michigan, they gave Vermont top rating among the states as a copper producer. For several years the M.I.T. students in Mining Engineering were taken to these properties for a summer course which was given in mine surveying.

The Elizabeth Mine has proved to be the most important. For some years after its discovery it was operated to produce copperas (iron sulfate) used for making red paint. The property was operated successfully by the Vermont Copper Company beginning in 1870 At first the ore was shipped to Connecticut for treatment, but in 1885 there were 24 brick furnaces smelting the ore at the mine. The plant was remodeled in 1889–1890 and a concentrator constructed at an estimated cost of $700,000. George Westinghouse bought the property in 1897 and operated it until 1902. It is estimated that previous to the reopening of the property in World War II, the total production had been 400,000 tons of ore – averaging 3.3 per cent copper, and at one time it was the largest copper mine in the United States.

The Ely Mine declared $100,000 in dividends in 1865 but was bankrupt in 1883. The property was reactivated in 1888 and operated until 1892. It was sold to George Westinghouse in 1899 who conducted some experimental work for a few years and then sold it in 1917. The high price of copper during World War I stimulated some activity during that period. In the early operations, the sulfur was burnt off by heap roasting and the product smelted in water-jacketed blast furnaces.

The Pike Hill property was worked intermittently from 1860 to 1889, again from 1905 to 1907, and for a short time in World War I.

The present Vermont Copper Company which is operating the Elizabeth Mine has also acquired the Ely and Pike Hill properties.

Operations were commenced during World War II and are still proceeding satisfactorily. The development of differential flotation since the earlier operations has made possible the production of a concentrate with more than 30 per cent copper. Diamond drill exploration has developed a substantial ore body which has justified equipping the property with modern mining and concentrating machinery.

The sulfide tailings from the concentrating operations containing the high sulfur minerals, pyrite and pyrrhotite, are being sold to the Brown Company of Berlin, N. H., to provide sulfur dioxide for the treatment of wood pulp for paper manufacture.

This is the outstanding mining operation in New England today. The ore produced will yield 300 tons of copper per month containing traces of gold. There are 225 miners employed. The shaft is 975 feet deep and from it numerous drifts extend into the ore body. The present concentrating mill will handle 500 tons of ore per day.

Among nonmetallic minerals Vermont has been a producer of considerable quantities of asbestos and talc.

Massachusetts

Thomas Dexter discovered bog iron ore in Saugus in 1628 but it is not definitely known if other discoveries preceded this. As stated earlier in this discussion, John Winthrop, Jr., went to England to seek assistance in developing an iron industry in the colony. He returned with 1,000 pounds in capital and some operating personnel. His name is associated with three ventures in Massachusetts: one in the north precinct of Braintree, now Quincy; one in what is now Weymouth; and one in Saugus. The Weymouth site was granted to him but apparently never built upon except for a small forge.

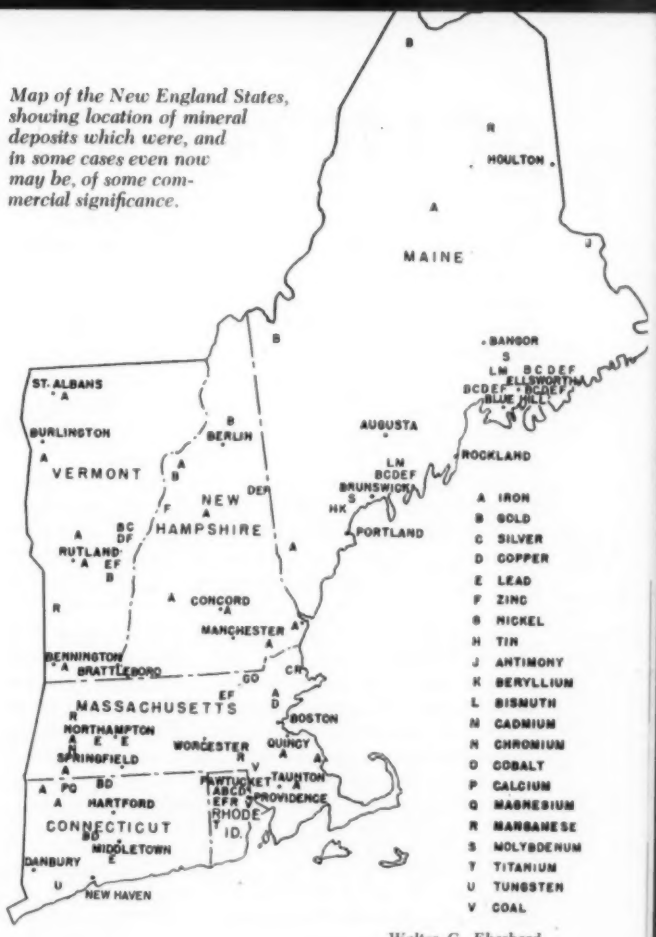
In November, 1643, nearly two years before the start of the Saugus furnace, a finery forge was begun in Braintree where a grant of 3,000 acres of land had been obtained but the work was not completed until 1645. A blast furnace was also constructed but it does not seem to have been entirely successful. Data are lacking regarding the details of this venture and the reasons for lack of complete success are not surely known. It is fair to assume that either insufficient ore or the poor quality of that available may have hampered the operations.

As this number of The Review is about to go to press, some excavations have begun on the site of the iron furnace in Quincy. The foundations have been uncovered and further discoveries are anticipated.

The furnace at Saugus has been officially designated as the first iron works in America. An earlier furnace is known to have been built in Virginia, but as smelting was about to begin, the operating crew was attacked by Indians; some were killed, others dispersed, and the equipment was destroyed. There is a difference of opinion as to whether iron was first produced at Saugus or at Braintree (Quincy) but the Saugus furnace was near a substantial deposit of good bog iron ore, and, from the start, continued for some years in successful operation.

Ore smelting was not profitably carried out in Quincy, although the plant continued to operate as a refining forge for treating some of the crude iron produced at Saugus. In 1648 Governor Winthrop wrote that the Saugus plant was producing seven tons per week. There is evidence that the Quincy plant operated until 1691, though the Saugus operations ceased in 1675.

Numerous deposits of good bog iron ore were found in Plymouth County and what is now Bristol County



Map of the New England States, showing location of mineral deposits which were, and in some cases even now may be, of some commercial significance.

Walter C. Eberhard

and these formed the basis of successful iron works. One of the first was established in the Raynham section of Taunton in 1652 by Henry and James Leonard, and Ralph Russell. This plant was operated by several generations of the Leonard family for over 200 years.

At least one furnace near Plymouth imported some ore from New Jersey. In 1804 there were 10 blast furnaces in Plymouth County producing iron castings. Other furnaces were established in Norton, Dartmouth, Cohasset, Topsfield, and Ipswich.

Deposits of iron carbonate exist in Stockbridge and some limonite and hematite (red iron oxide) extend from Connecticut through the Berkshire area to Bennington, Vt. In 1937 about 4,000 tons were mined in the Massachusetts section of this deposit.

Some chrome iron ore has been found in Chester and some manganese minerals at other Berkshire points.

Lead was discovered at Northampton in Hampshire County in 1679. B. K. Emerson in *U. S. Geological Survey*, Monograph No. 29, quotes the following from the old town records:

"At a legal meeting held October 16, 1679 . . . they then had further conference about the lead mine which Robert Lyman found out. They then voted that all such persons as would join in carrying out that design should meet on the 23rd of this instant at Sun one hour high at night and to have them or to those persons that shall appear the town do hereby give up all their right in that mine lying about six miles off at the west side of town."

A shaft was opened on this property in 1769 and bullets were made here in the early days of the American Revolution. It was not operated again until 1809 and work ceased in 1832. The shaft depth had reached 60 feet in 1810 and the lowest level was 990 feet.

The Chipman Mine at Newbury in Essex County, more commonly called the Newburyport silver mine, attracted considerable attention from 1874 to 1878. The vein was lead sulfide carrying considerable silver. The shaft was sunk to 230 feet and 1,500 tons of sulfide concentrates were produced having an average value of about $100 per ton. There was great excitement when the vein widened to six feet but it soon pinched out and the mine was abandoned.

Some details regarding the discovery and operation of the Chipman, sometimes called the Merrimac, Mine are given by Frederick E. Green in a letter to the *Engineering and Mining Journal-Press* (March 17, 1923, page 483), from which the following is quoted:

> Hundreds of holes were blasted out in Newbury from 1874 to 1880 over a territory five miles square. Custom smelters were built on the wharves of Newburyport and others in the wild part of Newbury, where most of the mines were located. The Merrimac had its own smelter and mill and was the only company to pay dividends. It paid nearly $100,000 in one of the years that it was operated but would not have done so if notice had been taken of worn out machinery and new machinery needed, or the development work necessary to find new ore bodies.
>
> When capital had to be replaced it was hard work raising it and ruined the value of the stock. When after this the mine was sold out the new company fully equipped it with new machinery but discovered too late that they had bought a salted mine and had no ore to treat. This company did not attempt to find more ore but closed down for good.

In 1919 the mine was reopened and $140,000 was spent during the next three years, but the work ended in failure and the property was sold in 1922 for $1,500.

One deposit of copper minerals has been recorded in Massachusetts. It was between Topsfield and Danvers but was apparently of little importance for no mining operations resulted from it.

Zinc sulfide, associated with lead and containing some gold and silver, has been mined at Sterling. The operations were of little importance.

Nickel with some cobalt and small amounts of copper, gold, and silver occurs in a deposit of sulfide minerals at Dracut, but although the mining of this ore has been attempted on several occasions, the operations have thus far proved to be unprofitable.

Manganese has been reported at Plainfield but the ore is low grade and no attempt has been made to exploit it.

A substantial deposit of iron pyrites occurs in the Davis Mine at Rowe, Franklin County. Although it contains some copper, its principal interest is as a source of sulfur. The mine was opened in 1882 and has been operated on several occasions. It is now attracting new attention because of the increasing interest in sources of sulfur.

A large deposit of coal exists in southeastern Massachusetts, beginning at about Mansfield, and extending southward into Rhode Island. This coal has attracted attention over many years and numerous attempts have been made to develop it into a useful fuel. The late Professors Robert H. Richards, '68, and Charles E Locke, '96, of the M.I.T. Mining Department, among others, gave the matter attention at several times, particularly during the New England coal shortage of World War I. The carbon content, however, although fairly high, closely resembles graphite and all attempts to make it a satisfactory fuel have resulted in failure.

Rhode Island

Joseph Jenks, Jr., son of Joseph Jenks, master mechanic at the Saugus, Mass., iron works, erected a forge at Pawtucket in 1675 and manufactured various articles including muskets. Jenks became an important figure in the colony and at one time served as governor (1727–1732).

The iron operations in Rhode Island were hindered by the fact that much of the bog ore existing there was unsuitable for producing metal of the quality required for nails, spikes, and tools.

A furnace known later as the Hope Furnace was built in 1835 by Samuel Waldo at Scituate, and several furnaces sprang up in Cumberland based on the magnetic oxide deposits there. The use of this ore gave difficulties because of the presence of titanium, but nevertheless a considerable production of munitions in the early days of the Nineteenth Century is recorded as well as bar iron, nails, farming implements, stoves, pots, and other household utensils. Iron for shipbuilding and other uses was also manufactured.

The ore from Iron Mine Hill in Cumberland contained 30 to 32 per cent iron and 10 per cent titanium oxide. It was usually mixed with hematite from Cranston before smelting. Cannons for the Louisburg expedition were cast here.

Minerals of copper, zinc, and manganese (some of the former carrying gold) have been found in Rhode Island but not profitably mined. These deposits are nearly all found at Copper Mine Hill in Cumberland. A small amount of molybdenite has also been reported. In 1840 an observer reported 50 prospect pits in this district.

Reference has already been made to the coal seam which underlies a section of southeastern Massachusetts. This seam extends southward, under the city of Providence, and a large contiguous area. The Rhode Island portion of this seam is apparently thicker and the coal of slightly better quality than that in Massachusetts for there are records that a copper smelter formerly operated in Taunton, Mass., used considerable coal from this district, and a mine operated in Cranston until very recently was able to sell its product. The present general opinion is that this coal is not competitive with that from other recognized coal districts.

Connecticut

From 1658 to 1762 all the iron produced in Connecticut was derived from bog ore. The earliest operations were by John Winthrop, Jr., and Captain Thomas

(Continued on page 268)

Premedical Education at M.I.T.

The Institute Has No Course Designed Solely for Premedical Students, Yet the Record of Alumni Who Have Entered the Medical Field Is an Impressive One

By MYLES MAXFIELD

As a rather unusual type of educational institution, M.I.T. assumes a peculiarly important position in the over-all picture of premedical education. Technology sends about 14 students to medical schools each year. These students graduate from the several courses, none of which has been designed primarily for future medical students. The Biology Department alone has formed its curriculum with a consideration of the needs of premedical students. In view of these things it is well to consider carefully this phase of education at M.I.T.

In particular, answers to the following questions should be sought: 1. What type of education, other than specific medical school education, is most needed and desired by physicians? 2. How can this best be furnished at M.I.T. within the existing organizational setup? 3. What recent innovations have been made directly to assist the student to become a better physician and a more valuable member of his community? 4. What is the record of M.I.T. Alumni in medical schools? Does this indicate that there is a satisfactory program of premedical education at M.I.T.?

With regard to the first question, medicine is an extremely broad and heterogeneous field. The patient must be studied from the point of view of his position in society or in his family, his mental or emotional problems, and his surgical, internal medical, physiological, biochemical, or biophysical problems. There are indeed medical specialists who study the patient from each of these points of view with special skills. But the point to be made very clear is that each patient is a single organism and must be studied with competence by any physician from all points of view. Medicine with all its specialties must nevertheless be regarded as an integrated whole. It is fully as bad for a physician to be ignorant of the biochemistry underlying a patient's discomfort as it is to be ignorant of his psychological pressures and motives. The point here is not to deplore specialization in medicine, which is certainly necessary but to deplore narrowness of thought.

The conclusion to be derived from this is that each student should obtain a solid grounding in both the natural sciences and in the humanities and social sciences, since what he will obtain of these in medical school will be almost incidental. Certain courses of study, such as biology, chemistry, physics, English, and foreign language are required for entrance to most medical schools, and a knowledge of the material in these courses is assumed in the teaching of technical courses in medical school. These required courses occupy a little more than one quarter of the average premedical curriculum.

How is one to reconcile these two facts – namely, the tremendous amount and breadth of training desirable in medicine, and the comparatively small number of courses required for entrance to medical school? Perhaps the answer may be expressed somewhat as follows: Definitive training for medicine consists of medical school courses plus the required premedical courses. The remaining time is for premedical education as opposed to training. By education is meant a definite, but difficult to describe, developing of the factual knowledge, attitude, and judgment which are required for a mature and useful life in our world today. This remaining time in premedical school is very important in a physician's formal training and should be given the most careful consideration by each individual student.

In general, the student should seek to become competent in some small area of learning of his own choosing, not necessarily related directly to medicine. Also he should increase the breadth of his background as much as possible with elementary courses in other areas, participating in discussion groups and extracurricular activities.

The course structure at M.I.T. is such that these principles may be especially well realized. Each student has a choice of some 20 courses in any of which he may major to become competent. There are in each course elective hours enough to satisfy entrance requirements for medical school and to broaden his educational background. There is no course at M.I.T. designed solely for premedical students, nor in our opinion should there be one, because this would tend to prevent the expression of individual interest in a special field of study. It would tend to create much too high a degree of uniformity among premedical students. Also, the tendency to offer, in such a special premedical curriculum, special dilute science courses for these students should not be overlooked. The Institute abounds with excellent courses in many fields taught by stimulating men of exceptional ability, and the opportunity must be preserved for premedical students to take advantage of these courses. It is exactly this that is responsible for the importance of M.I.T. in premedical education.

Course VII, Biology, most nearly occupies the position of a premedical course. Most Biology majors are

(Continued on page 262)

THE INSTITUTE GAZETTE

PREPARED IN COLLABORATION WITH THE TECHNOLOGY NEWS SERVICE

In the Ballot Box

BALLOTS bearing the date of March 20 will be mailed to the M.I.T. alumni body of 44,000 to provide for nomination and subsequent election of: officers of the Alumni Association; alumni term members on the M.I.T. Corporation; members of the National Nominating Committee; and class representatives on the Alumni Council.

The Association's presidential nominee, for a term of one year, is Hugh S. Ferguson, '23, XV, President of Dewey and Almy Chemical Company of Cambridge, Mass.

To assist Mr. Ferguson in administering the affairs of the Alumni Association for the fiscal year beginning July 1, 1954, the slate of the National Nominating Committee lists Gilbert M. Roddy, '31, XV, as vice-president for a term of two years. Mr. Roddy is vice-president of the Boston Manufacturers Mutual Fire Insurance Company and Mutual Boiler and Machinery Insurance Company, Boston. He is president and director of the Emerson Hospital in Concord, and a trustee of the Boston Museum of Science, Wheaton College, and the Home Savings Bank of Boston. Active in alumni groups since 1936 when he was Class Representative on the Alumni Council, he has also acted as Class Agent. Among the committees in which he has held membership are: the Student Welfare Committee, Boston Luncheon Club Committee, Committee on Nominations for Departmental Visiting Committees, and the Advisory Council on Walker Memorial. Mr. Roddy is director of the Concord Community Chest.

The National Nominating Committee (which presents names of candidates for nomination and election) is composed of: Raymond H. Blanchard, '17, chairman, Laurence P. Geer, '15, Saxton W. Fletcher, '18, Harold E. Koch, '22, Whitworth Ferguson, '22, George P. Edmonds, '26, Richard L. Cheney, '27, Robert J. Joyce, '28, Albert R. Pierce, Jr., '31, and George E. Colby, '32. For the two new members to serve for two years on the Executive Committee of the Alumni Association, the above Committee has named: Donald W. Kitchin, '19, V, Research Laboratory of the Simplex Wire and Cable Company, Cambridge; A. Robert Tonon, '22, XV, President and Treasurer, Peter Gray Corporation, Cambridge.

Nominated to serve for five years on the Institute's Corporation, as alumni term members, are: Ray P. Dinsmore, '14, X, Vice-president, Goodyear Tire and Rubber Company, Akron, Ohio; William J. Sherry, '21, X, Oil Producer, Tulsa, Okla.; and this year's president of the Alumni Association, Horatio L. Bond, '23, XV, Chief Engineer, National Fire Protection Association, Boston.

Selected as representatives on the National Nominating Committee (one to be named from each district) are: *District 3* – New Haven – Harold G. Manning, '12, X; Hartford – Arthur F. Peaslee, '14, I; Bridgeport – David J. Sullivan, '24, X; *District 6* – Pittsburgh – Charles M. Boardman, '25, XV; Charleston – William S. Brackett, '23, X–A; Scranton – William L. Dennen, '17, XII; Bethlehem – Edmund J. Flynn, '19, X; Philadelphia – Samuel K. McCauley, '41, X and XV; Harrisburg – Harold R. Spaans, '30, XV; Washington, D.C. – George W. Stone, '89, IV; *District 7* – Louisville – Archie P. Cochran, '20, XV; Detroit – Morgan A. Collins, Jr., '27, I; Columbus – Garry C. Myers, Jr., 2–44, XVI; Dayton – William G. Payne, '27, XV; Chicago – Edgar F. Seifert, '19, V; Cleveland – G. Richard Young, '37, XV.

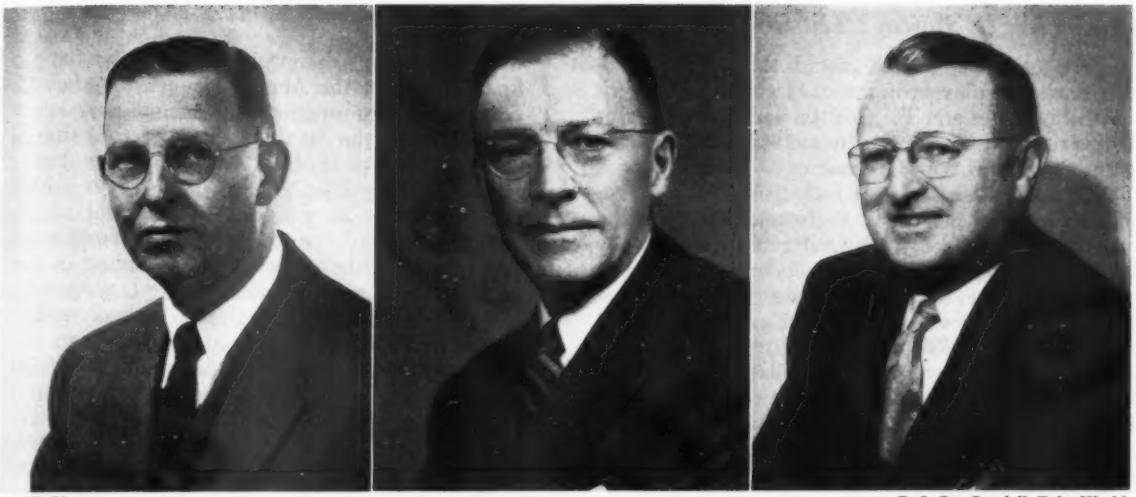
Classes whose numerals end in either five or a zero will vote for a Class Representative on the Alumni Council who will serve for a term of five years.

PRESIDENTIAL NOMINEE

Kampper, Belmont

Hugh S. Ferguson, '23, XV, President of the Dewey and Almy Chemical Company, Cambridge, has been nominated as president of the Alumni Association for the fiscal year beginning July 1, 1954. In 1951-1953, Mr. Ferguson was vice-president of the Alumni Association, and in 1948-1950 a member of its Executive Committee. He has served on the Alumni Council, and as a member and as chairman of several committees of the Alumni Association.

In addition to M.I.T. activities, Mr. Ferguson is treasurer of the Executive Committee of the Belmont Hill School, Inc., and a trustee of the Home Savings Bank and of the Mount Auburn Hospital in Cambridge. He is a member of the Chemists' Club (New York City), Union Club (Boston), and Newcomen Society of England (American Branch).



M.I.T. Photo *D. LeRoy Randall, Tulsa World*

Horatio L. Bond, '23, XV **Ray P. Dinsmore, '14, X** **William J. Sherry, '21, X**

Nominated to serve as alumni term members on the M.I.T. Corporation for a period of five years, beginning July 1, 1954, are (from left to right): *Messrs. Bond, Dinsmore and Sherry. Mr. Bond, this year's president of the Alumni Association, is chief engineer of the National Fire Protection Association, Boston. From Akron, Ohio. Mr. Dinsmore serves as vice-president of the Goodyear Tire and Rubber Company. Long affiliated with petroleum engineering, Mr. Sherry is an oil producer in Tulsa, Okla.*

Boston Midwinter Meeting

WALKER Memorial was the scene of the 1954 Midwinter Meeting of Technology Alumni in Greater Boston, and more than 500 Alumni and friends attended the dinner and meeting on Thursday, February 4. As President of the Alumni Association, Horatio L. Bond, '23, opened the meeting, and introduced James R. Killian, Jr., '26, President of the Institute, and Horace S. Ford, Acting Director of the M.I.T. Division of Defense Laboratories, who was master of ceremonies, in a program describing some of the research activities of the National Research Corporation, Arthur D. Little, Inc., and Godfrey L. Cabot, Inc.

Reporting on the new developments at M.I.T., President Killian announced that the Institute has received $160,000 during the current academic year for undergraduate scholarship aid. "Yet in spite of this encouraging current level of giving," Dr. Killian said, "the Institute urgently needs to increase its capital funds for undergraduate scholarship endowment." He reported:

> In common with many colleges and universities, scholarship applications at the Institute continue to show a sharp upward trend. For the class which entered this fall, M.I.T. experienced a 50 per cent increase in scholarship applications, and all indications are that this year they will be nearly two and one-half times what they were four years ago.
>
> For this reason, it is clearly encumbent on us to find the means to extend our undergraduate scholarship aid. Our objective is to increase our present capital funds for undergraduate scholarships by more than three million dollars by 1957.

In speaking of the gifts received to date this year, Dr. Killian said that more than $100,000 is for current aid and that more than $50,000 is for undergraduate scholarship endowment.

Twelve foundations and 15 industrial concerns have made contributions for current aid. The largest new foundation gift is $16,650 from the Sloan Foundation. This contribution will be increased each year for the next three years to cover the terms of the new Alfred P. Sloan National Scholarships.

Largest industrial contributor to current funds is Holmes and Narver, Inc., Engineers and Constructors, of Los Angeles. James T. Holmes, President of the firm, was graduated from the Institute in the Class of 1914. This grant is in the amount of $10,000.

Among the grants given for endowment, Dr. Killian made special mention of those of Whitehead and Kales Company of Detroit; the Doelcam Company of Boston; and the Boston Stein Club.

The William R. Kales Scholarship Fund was named by Robert G. Kales, '28, in memory of his late father, an alumnus of the Institute in the Class of 1892 and a former member of the Institute's Corporation (*see* caption, page 256). This fund and that of the Doelcam Corporation, of which John J. Wilson, '29, is president, are for $10,000 each.

The Boston Stein Club gift for undergraduate scholarship-loan endowment is for $3,500. This is in addition to the Club's $40,000 Karl Taylor Compton Prize Fund award.

Other speakers on the program included: John H. Durant, Business Manager, Research Division, National Research Corporation, who demonstrated a method of depositing metallic films on nonmetallic materials; Warren A. Berg, Director of Public Relations, Arthur D. Little, Inc., who explained how electronic circuits were being used as an aid in studies of operational research; and Charles A. Stokes, '40, Director of Research and Development, Godfrey L. Cabot, Inc., who spoke on the role of carbon and silica products and their extensive use in rubber tires for the automotive industry.

Frederick H. Bailey: 1865-1954

With regret The Review records the death of Frederick H. Bailey, Professor of Mathematics, Emeritus, in Winter Park, Fla., on January 13. Professor Bailey retired from the faculty in 1935, after 44 years in the Department of Mathematics.

In collaboration with his colleague, the late Professor Frederick S. Woods, Professor Bailey wrote a number of textbooks which were widely used in the undergraduate teaching of mathematics.

He was born in Leominster, Mass., in 1865, and received the degrees of bachelor of arts in 1887 and master of arts in 1889 at Harvard University. For the following two years Professor Bailey served as assistant instructor in mathematics at Harvard, and in 1891 he was appointed instructor on the Institute staff. He was promoted to assistant professor of mathematics in 1893, associate professor in 1904, full professor in 1907, and professor emeritus in 1935.

In addition to his long career at M.I.T., Professor Bailey was instructor in mathematics at Radcliffe College in 1890 and 1891, and at Simmons College in 1902 and 1903. He was for many years a member of the American Mathematical Society.

Study for Executives

Dean E. P. Brooks, '17, of the M.I.T. School of Industrial Management, has announced receipt of a new grant of $170,000 by the Alfred P. Sloan Foundation, Inc., in support of the Executive Development Program for the coming year. This grant, he pointed out, is one of a series made in support of the Executive Development Program by the Sloan Foundation since 1938. During 1954–1955, it will be used to provide cash awards to winners of the fellowships, to cover costs of such special group activities as dinners and field trips, and to support and strengthen the educational resources which M.I.T. devotes to the program.

Fellowships for the 1954–1955 Program, Dean Brooks said, will be given to young executives who are nominated by their employers on the basis of "marked promise of growth into major executive responsibilities." The nationwide competition will close on March 5, 1954. Applications and further information are now available from Gerald B. Tallman, Associate Professor of Marketing, who is director of the Sloan Fellowship Program for Executive Development at M.I.T.

The year's study in the Executive Development Program is devoted to fundamental problems of business enterprise. "Despite their years of successful activity in special phases of industry, most young executives lack a familiarity with the wide range of essential business functions foreign to their own experience," Professor Tallman explained at the opening of the competition.

Participation in the Executive Development Program is limited to between 30 and 36 recipients of Sloan Fellowships. Nomination by an employer is a prerequisite, since employers co-operate in the program by sponsoring these men and by providing successful candidates with a year's leave of absence and financial aid. Fellows are drawn from both large and small companies in various types of industry.

No. 300

Four Technology Alumni who were present at the first meeting of the Alumni Council on May 12, 1909, and 13 past presidents of the Alumni Association were present at the 300th meeting of the Alumni Council on January 18. In attendance at this dinner meeting at the M.I.T. Faculty Club – over which Horatio L. Bond, '23, presided as president of the Association – were 146 members and guests. In ceremonies fitting for the occasion, the founding of the Association of Class Secretaries, the Alumni Association, the Technology Club, and The Technology Review was recalled during the social portion of the meeting, after regular items of business had been disposed of.

As Secretary of the Association, Donald P. Severance, '38, reported changes of class affiliation for five Alumni; that nine members of the M.I.T. staff had made visits to 16 local M.I.T. clubs – from Rochester to Mexico City, and from Providence to San Francisco. Also reported, as recorded on pages 252 and 253, were nominees for election to office in the Alumni Association. As of January 18, it was also reported that $156,117.68 had been contributed by 6,501 Alumni to the Alumni Fund for the current year.

President Bond, at the conclusion of the business portion of the meeting, turned the meeting over to Charles E. Smith, '00, President of the Alumni Association for the year 1934–1935, who acted as master of ceremonies for the rest of the meeting. Other past presidents of the Association who were present and introduced by Mr. Smith were:

Samuel C. Prescott, '94	President 1927–1928
Bradley Dewey, '09	President 1931–1932
Redfield Proctor, '02	President 1933–1934
Marshall B. Dalton, '15	President 1937–1938
Henry E. Worcester, '97	President 1940–1941
Francis A. Barrett, '24	President 1942–1943
Raymond Stevens, '17	President 1944–1945
A. Warren Norton, '21	President 1945–1946
Harold Bugbee, '20	President 1946–1947
Raymond H. Blanchard, '17	President 1947–1948
John A. Lunn, '17	President 1950–1951
Alfred T. Glassett, '20	President 1951–1952
Edwin D. Ryer, '20	President 1952–1953

First speaker of the evening was Walter Humphreys, '97, Secretary-Treasurer of the Association from 1907 to 1923, and Secretary on the occasion of the first meeting of the Alumni Council on May 12, 1909. In addition to Mr. Humphreys, others present at the January 18 meeting, who were also present at the first meeting of the Alumni Council, were, Samuel C. Prescott, '94, Andrew D. Fuller, '95, and Dr. John A. Rockwell, '96. A letter from the Institute's Acting President, Arthur A. Noyes, '86, and discussed at the first Alumni Council meeting in 1909, was read by Mr. Humphreys at the Council's 300th meeting. In this letter, Dr. Noyes recommended that alumni committees on the various departments be appointed to co-operate with the Visiting Committees of the Corporation, which at that time did not have alumni representation. He proposed that the Alumni Council make provisions for the development of local M.I.T. clubs throughout the country and proposed that Alumni promote the foundation of scholarships for sending boys to the Insti-

tute, and hoped that the Alumni Council would participate in providing satisfactory living places for the students as soon as the location of the Institute was definitely decided.

Dr. Prescott was next called upon to discuss some of the giants among our earlier graduates and Faculty, and some of the events of that era of 50 years ago which were important and critical not only for the Association but for the Institute itself. In particular, he mentioned the founding of the Technology Club, the Association of Class Secretaries, the founding of The Review, the bitter controversy over the proposed merger of the Institute and Harvard, and the consequent establishment of Alumni Term Memberships on the M.I.T. Corporation. Dr. Prescott closed his presentation by the following quotation from an article by Walter B. Snow, '82, written in 1909 for The Review:

"The Alumni Association is no longer young. It is now in a position to do man's work. Upon the composition of the Council, the central feature of the new form of organization, must depend largely the standing and influence of the Association as a whole. Election to this body should be comparable in honor to election as a candidate for the Corporation."

Mr. Smith next presented Marshall B. Dalton, '15, who, as 44th President of the Association, presided over the 200th meeting of the Alumni Council in May, 1938 – at the time of the campaign to raise $1,500,000 for a gymnasium and swimming pool – and later accepted the chairmanship of M.I.T.'s successful Development Fund campaign for $20,000,000. In speaking on the broad topic of corporate support for higher education, Mr. Dalton reminded his listeners that 1,500 colleges and universities, mostly private, receive the amount of $1,350,000,000 from student fees, endowment gifts and federal, state and local participations – which is $250,000,000 short of their needs.

As individuals of great wealth pass on and are unable to support education to the extent they did in the past, corporations increasingly recognize that partnership with education justifies broader corporate support. Congress recognizes this need as shown by the 5 per cent deduction allowed for contributions to education; 29 states recognize the problem by permissive legislation; the U. S. Chamber of Commerce and many professional organizations encourage corporate support; and the New Jersey Supreme Court settled the famous A. P. Smith Manufacturing Company *versus* Barlow case in favor of Princeton University. In particular, the Superior Court concluded:

"Such giving may be called an incidental power, but when it is considered in its essential character it may well be regarded as a major though unwritten corporate power. It is even more than that. In the court's view of the case it amounts to a solemn duty."

As final speaker of the evening, Karl T. Compton, chairman of the M.I.T. Corporation, spoke of the many ways in which Alumni have helped M.I.T. survive some of its crises and have assisted him and his associates in the discharge of their duties.

A nation's educational system appears to develop according to its current needs. So, too, changes at M.I.T. have conformed to the needs of the times as has been indicated by the increase in research and science in the period between the two world wars, and the marshaling of our resources for national defense and security since the beginning of World War II. Similarly, the Alumni Association has shown an ability to grow in spite of adverse environments. For example, in the early 1930's when enrollment had declined, the Institute turned to a group of Alumni to serve as local representatives of the Alumni Association and Honorary Secretaries to help maintain enrollment at reasonably constant figures.

Despite the limited number of students which M.I.T. can admit each year, the Institute's Administration recognizes its obligation to encourage the enrollment of those students who are best qualified and give greatest promise of using M.I.T. educational resources most advantageously. Again the Institute has turned to a selected group of its younger Alumni to serve as Educational Counselors in their respective communities. By keeping in touch with college preparatory schools in their communities, by interviewing prospective candidates and assisting them and their families to understand the Institute more fully, the Educational Counselors, as well as the Honorary Secretaries, greatly assist the Admissions Office in enrolling the best qualified candidates for admission. Dr. Compton concluded his remarks with a tribute to the service which Alumni have rendered in serving as members of the various Departmental Visiting Committees, or as members of the M.I.T. Corporation.

Joseph W. Powell: 1877-1954

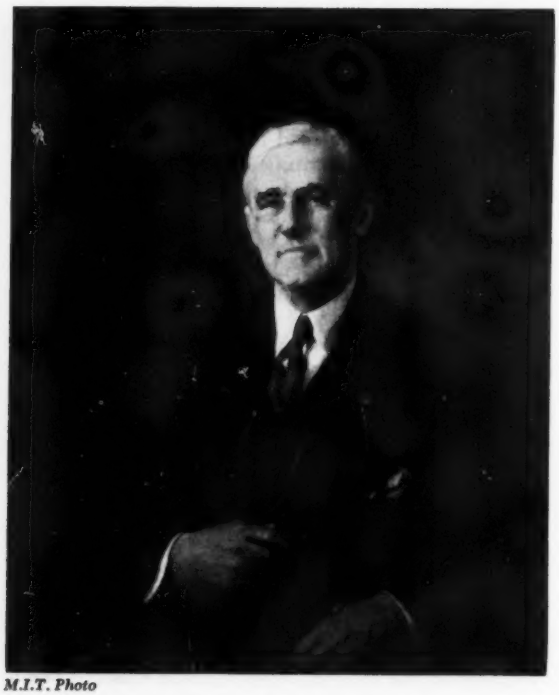
ANNOUNCEMENT of the death of Joseph W. Powell on January 25 was sadly received in The Review Office. Mr. Powell was a life member of the Institute's Corporation and a shipbuilder of international reputation. Born in Oswego, N.Y., in 1877, Mr. Powell was graduated from the U.S. Naval Academy in 1897. Following graduation, he took postgraduate work in naval architecture and marine engineering at the Academy, and subsequently studied for a year at the University of Glasgow.

Mr. Powell resigned from active duty in the Navy in 1906 to accept the position of assistant to the president of Cramp's Shipbuilding Corporation. In 1914 he became president of the Fore River Shipbuilding Corporation and in 1917 was appointed vice-president in charge of all yards controlled by the Bethlehem Shipbuilding Corporation, Ltd.

From 1921 to 1922, Mr. Powell served as president of the U.S. Shipping Board Emergency Fleet Corporation and from 1930 to 1939 he was president of United Shipyards. Since 1944 Mr. Powell had engaged in engineering projects relating to shipbuilding and shipping.

Mr. Powell served on the U.S.S. *New York* during the Spanish American War, and was a valued leader in the shipbuilding program of World War I. During World War II, Mr. Powell served as a special assistant to Secretaries of the Navy – Frank Knox and James V. Forrestal – and was also deputy chief of the Office of Procurement and Material of the Navy Department.

Mr. Powell was a trustee of Webb Institute and director of a number of corporations. He was also a past president of the Society of Naval Architects and Marine Engineers.



M.I.T. Photo

William R. Kales, '92

. . . from a portrait by Harold Brett . . . in whose honor the William R. Kales Scholarship Fund for undergraduates has been established at the Institute by Whitehead and Kales Company of Detroit, Mich. This scholarship fund for worthy and needy undergraduates was named by Robert G. Kales, '28, in memory of his late father, a former member of the Institute's Corporation. Income derived from investment of the gift will provide the scholarships, and winners will be selected by the Faculty Committee on Student Aid.

Builders of Towns

EXCEPTING the absence of Harry J. Carlson, '92, all members of the Visiting Committee on the School of Architecture and Planning* met with Pietro Belluschi, Dean of the School of Architecture and Planning, and other faculty members of the Department, on March 20, 1953. Dean Belluschi and the chairman of the Committee held an informal meeting on April 6 with James R. Killian, Jr., '26, President of M.I.T., Julius A. Stratton, '23, Vice-president of the Institute, and John E. Burchard, '23, Dean of the School of Humanities and Social Studies, since none of these administrative officers could be present at the March 20 meeting. The report of the Committee was made available for publication on July 29, and the following paragraphs summarize the major points in the report.

The demand for graduates trained in City Planning is well in excess of present supply, especially for positions in government. The needs of students in City Planning closely parallel those of students in Architecture, and the Committee agreed that a five-year Course in City Planning, combined with existing facilities in the Department of Architecture, was desirable.

* Members of this Committee for 1952-1953 were: William Emerson, chairman, Harry J. Carlson, '92, Carl L. Feiss, '38, Harry M. Weese, '38, Walter A. Gropius, Eero Saarinen, and Harlow Shapley.

Great interest was aroused and hearty approval expressed for the idea of a Center for Urban Studies at M.I.T. The problems besetting cities nowadays are multiplying at an alarming rate, while no organization, public or private, is set up to facilitate their proper research and study. This center would not only be an instrument for research, but would offer the City Planning students an opportunity to extend and give practical application to their professional education supplementing the theoretical problems at the School.

The Committee wishes to recommend to the favorable consideration of the Corporation such financial support as may be possible for the establishment of a Center of Urban Study at M.I.T.

The Committee deliberated the advisability of giving greater flexibility of choice to architectural students in such fields as structures, visual design, city planning, and related topics, particularly if the curriculum in the freshman year is liberalized. There was general and hearty approval of this idea in principle. At the present time such procedure is recognized in the work of graduate students who avail themselves of existing courses in construction, illumination, and acoustics, to their great advantage. The Committee feels that flexibility in the curriculum should not be carried so far as to lose sight of fundamental principles in basic design.

The proposal for a Materials and Techniques Laboratory suggested the value to the architectural student of acquaintance, during his undergraduate years, with the nature and behavior of materials that he will later have to employ. This knowledge he can secure only inadequately during the summer months. Certain facilities, such as those for testing materials, are already available. The realization of such a laboratory lies in a distant future, but the need is real.

The need of financial support for scholarships and other activities at the School was recognized and the organization of a Committee for that purpose approved, the machinery to be developed in co-operation with the Development Office and in close consultation with Dean Belluschi.

Appointments and Promotions

RECENT Faculty appointments and promotions at M.I.T. were announced on February 1 by James R. Killian, Jr., '26, President of the Institute. Promoted to the rank of assistant professor is Vincent J. Roggeveen, '53, a member of the Department of Civil and Sanitary Engineering. Thomas P. Rona, '53, has been appointed assistant professor in the Department of Mechanical Engineering.

Military personnel recently appointed to the M.I.T. Faculty include: Colonel Charles M. McAfee, Jr., Associate Professor in the Department of Military Science; and Captain Edward H. Littlejohn, Captain James P. Smith, and Captain Frederick L. Wilson, Assistant Professors in the Department of Air Science and Tactics.

John O. Outwater, '50, has been named an industrial liaison officer at the Institute.

(*Continued on page 258*)

BUSINESS IN MOTION

To our Colleagues in American Business . . .

Like other companies whose people do outstanding work, Revere receives many letters of appreciation. They are a source of great gratification, first because we want to render service, and second because good work shows that the way we select, train, and promote men to positions of responsibility is the right way. Let us quote from a recent letter.

"Thank you for bringing your welding engineer to assist us in solving our problems.

"On his visit to our plant last month, he helped us to establish sound procedures and in so doing, eliminated several expensive errors we were unknowingly making. We are especially grateful to him for the energetic way in which he went about his work, in spite of physical difficulties encountered due to our plant being in full operation. We appreciate his patience in answering all questions with which he was bombarded by operators, supervisors, and management alike.

"It was a real pleasure to have your welding specialist and a technical advisor with us, and we hope it will be possible for you to visit us again soon under less strenuous circumstances."

Our interest in welding stemmed originally from the fact that years ago it became evident that the market for Revere Metals would be expanded considerably if customers could be shown how to make perfect welds, quickly and at minimum expense. A Welding Section was set up within the Research and Development Department, where it was given full laboratory facilities. The activity was organized on both scientific and practical lines, with capable personnel who have solved many problems. In one case, two men were flown to a customer's plant, where they worked 20 hours a day over a weekend, and by Monday afternoon had the satisfaction of seeing the customer's operators turning out perfect welds, saving a substantial sum in penalties for delayed delivery.

The normal procedure whereby the Welding Section is called into action is simple. Usually a Revere Salesman uncovers a welding problem, and calls in the Technical Advisory Service. Often a Technical Advisor can provide the needed know-how. If additional help is needed, he can get it from the Welding Section people.

You may not be at all concerned about welding metals, and never expect to be. That does not matter. Whatever you make, or how you make it, you may have problems. Our suggestion is that you look around among your suppliers and see if one or more of them may not have just the special skills that you can use to good advantage.

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THE INSTITUTE GAZETTE

(Continued from page 256)

Midwest Regional Conference

FOURTH of its kind since the first M.I.T. Regional Conference was inaugurated in 1951 under the leadership of Robert E. Wilson, '16, the Midwest Regional Conference on Science, Engineering, and Industrial Management, held in Detroit on Saturday, January 30, drew an attendance of approximately 250 persons. This full-day conference was held in the Horace H. Rackham Educational Memorial Building, where the Engineering Society of Detroit has excellent facilities for such events. General chairman of the conference was Charles A. Chayne, '19, Vice-president in Charge of Engineering of General Motors Corporation. Other committee chairmen were: *Hospitality* – L. Willis Bugbee, Jr., '21; *Finance* – Morgan A. Collins, '27; *Arrangements* – Robert C. Doremus, '14; *Publicity* – David M. Sutter, '26.

Conference speakers included Robert E. Wilson, '16 – Chairman of the Board, Standard Oil Company (Indiana) – and the following personnel from the Institute: James R. Killian, Jr., '26, President; E. P. Brooks, '17, Dean of the School of Industrial Management; Francis O. Schmitt, Head of the Department of Biology; Antoine M. Gaudin, Richards Professor of Mineral Engineering; John G. Trump, '33, Professor of Electrical Engineering; and Elting E. Morison, Professor of Industrial History.

As President of the Detroit M.I.T. Association, Adam K. Stricker, Jr., '29, opened the conference and then turned the meeting over to Mr. Chayne.

First of the morning speakers from M.I.T. was Professor Schmitt whose address "Perspectives in the Life Sciences" included comments regarding the Institute's program in this field, along the general lines recorded by Dr. Schmitt in the December, 1953, issue of The Review ("Biological Science at M.I.T.," page 85). The Institute's program in biology is one which emphasizes biology at the molecular level, and places great stress on recently developed techniques of instrumentation. Professor Schmitt envisioned the time when the human life span might be appreciably prolonged through ability to control degenerative diseases and the aging process.

"Mineral Resources Policy for the United States" was the title of the second address by Professor Gaudin. Because mining is a wasted asset, it is imperative to provide mechanisms for replenishing minerals which are being used at a constantly increasing rate. Dr. Gaudin recommended appreciable expenditures for geophysical prospecting on a long range, national scale, and made a strong plea for a return to an era of mutual self-respect at the international level, and a return to those national policies which encourage incentive to make investments in minerals – domestic as well as foreign.

(Concluded on page 260)

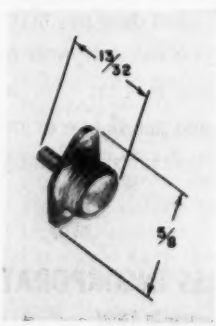
B.I.W.

MINIATURE COAXIAL CABLE ASSEMBLY

TEFLON INSULATED

PATENTED*

A FULL SIZE REPRODUCTION of a typical B.I.W. miniature cable assembly is shown. The degree of flexibility is indicated by the loop in the center. The range of cable sizes available vary from 3/32" to 5/32" depending upon the characteristics of the cable selected.



NEW SPECIALLY DESIGNED COAXIAL CONNECTORS are attached to these assemblies or are available from Diamond Manufacturing Company, Wakefield, Mass., Part DIC-2243 Plug (attached to cable) and Part DIC-2244 Receptacle (for panel mounting) shown at left. MADE TO ORDER ASSEMBLIES may be purchased in any specified lengths utilizing the cable with the proper capacitance and impedance to fill your needs. Or you may purchase the cable and connectors separately.

THESE MINIATURE CABLES ARE DESIGNED for high temperature operation and remain flexible at extreme low temperatures. They will not melt or become brittle at continuous ambient temperatures of 400° F. with relatively stable capacitance over range —65° F. to 400° F.

BIW TYPE NO.	CONDUCTOR RES. PER FT.	OUTSIDE DIAMETER	CAPACITY mmf/ft.	IMPEDANCE OHMS	LIST PRICE 100 FT.
COX-2FS-011-GL	.20 ohms	.075"	30	50	$13.00
COX-3FS-011-GL	.20	.090	21	70	16.00
COX-3FS-014-GL	.14	.100	21	70	18.00
COX-4FS-011-GL	.20	.125	16	90	21.00
COX-4FF-016-GL	.11	.160	13	95	45.00
COX-2FS- 22-GL	.02	.125	30	50	16.00

* Manufactured by B.I.W. under exclusive license under Patent #2454625

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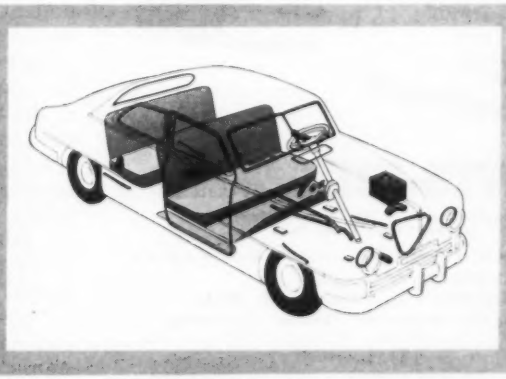
That new car you're driving is said to contain approximately 540 rubber parts*, and most of those rubber parts contain carbon black. Four pounds of carbon black in a tire adds 20,000 miles to its life, thus saving you the expense of several new tires each year . . . or saving you and all other motorists an estimated $1,000,000,000 annually. Your tires and tubes alone take 25 or 30 pounds of carbon black . . . at a cost of only 10¢ a pound.

Millions of pounds of Cabot blacks find their way into car and truck motors, bodies, tires and tubes each year. Rubber-carbon black compounds absorb shock and dampen vibration — do a hundred different things smoothly and efficiently. You'll find carbon black in the floor mats, rubber insulation, motor mountings, weather stripping, windshield wipers, heater hoses, vibration insulation — in fact, in most of the rubber at which you look. It's carbon black that adds the wear and tear resistance, much of the hidden comfort you've come to expect and don't realize is there. And carbon black isn't confined to the rubber parts alone, for it appears strikingly in the lustrous black finish and plastic trimmings as well.

*The Goodyear Tire & Rubber Company, Inc. Survey Report



Shaded and blackened areas denote some of the rubber parts used in today's average automobile. Courtesy of The Goodyear Tire & Rubber Company, Inc.

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THE INSTITUTE GAZETTE

(*Concluded from page 258*)

Final speaker at the morning session was Dr. Trump who spoke on "New Applications of Science in Medicine." Theoretical physics in the mid-Twentieth Century is primarily concerned with a study of the forces binding atomic nuclei together; the results of such studies are as important in our industrial and economic life as in physics and international relations. Dr. Trump took an optimistic view of the future of atomic physics, pointing out that the beneficial uses which radium and radiography had already brought to mankind had already decreased the formidableness of cancer and other malignant diseases.

The afternoon session was opened with a talk by Professor Morison on "Problems of Industrial Leadership." It has been said that industry threatens the cultural life of society. If this be true, said Professor Morison, a good case can be made for giving future business executives ample opportunity in their college courses to become acquainted with the history and progress of the industrial revolution as a means of enabling them to see the social – as well as the economic – effects of important business decisions they will be called upon to make, usually without adequate data at hand.

"Synergism Between Engineering and Petroleum" was the title of Dr. Wilson's address. He cited many examples in which the engineering field had assisted the petroleum industry, and reminded his listeners that, by making the modern internal combustion engine available, the petroleum industry, in turn, had made a major contribution to engineering. Dr. Wilson recalled that anticipation of just and ample rewards for one's service is the best synergist, and expressed the hope that political, economic, legal, and technological conditions can be directed toward this end.

After dinner, Dean Brooks spoke on "Toward a Science of Industrial Management," outlining the aims of the Institute's School of Industrial Management in somewhat the manner reported on in the June, 1953, issue of The Review ("School of Industrial Management," page 419). The thought disciplines which characterize science and engineering provide an important base for the training of those who follow studies in economics and industrial management. Since management decisions must usually be made in the absence of adequate information, effort is made in the School to develop men who can operate progressively in areas where complete data are lacking.

President Killian made the closing remarks at the conference. Speaking on the Institute's educational policy, Dr. Killian recalled that M.I.T. does about 1 per cent of the nation's research, and estimated that public service activities of the M.I.T. staff represent an annual contribution of more than $1,000,000.

Considerable increases in the efficiency of the educational process could be achieved in making the transition from high school to college (as the freshman adviser plan at M.I.T. has demonstrated) and again from college to industry, Dr. Killian stated.

THE TECHNOLOGY LOAN FUND BOARD

Report for the Year 1953

For the fifth calendar year since the war, new loans made exceeded repayments on outstanding notes, these totals for 1953 being $276,085 and $98,469, respectively. By the end of December, 1953, 2,591 individuals – or 65% of the 3,976 receiving loans since the Fund was established in 1930 – had completely discharged their financial indebtedness to it. The data presented below summarize the Loan Board's transactions during 1953 together with cumulative figures for the past 21 years.

THE TECHNOLOGY LOAN FUND BOARD

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J. J. Snyder
T. P. Pitre
J. T. Rule
D. L. Rhind, *Secretary*
H. E. Lobdell, *Chairman*

Cambridge
March 1, 1954

CUMULATIVE RECORD OF THE TECHNOLOGY LOAN FUND TO DECEMBER 31, 1953

	At December 31, 1953	*At December 31, 1952*		*Net Changes during 1952–1953*
ITEMS OF OUTGO:				
Number of men Receiving Loans	3,976	3,644	up	332
Total Amount Loaned	$2,924,013	$2,647,928	up	$276,085
Average per Capita Loan	736	727	up	9
ITEMS OF INCOME:				
Number of Men Whose Indebtedness has been Completely Discharged	2,591	2,467	up	124
Principal Repayments in Advance	$ 660,907	$ 639,927	up	$ 20,980
Other Principal Repayments	1,376,712	1,299,223	up	77,489
TOTAL PRINCIPAL REPAYMENTS	$2,037,619	$1,939,150	up	$ 98,469
Total Principal Matured, Considering "Advanced Repayments" as Matured When Paid	$2,071,978	$1,973,255	up	$ 98,723
Collection Ratio, i.e. Percentage of Total Maturities Paid	98.3	98.2	up	0.1
Matured Principal in Arrears	$ 24,782	$ 24,676	up	$ 106
Actual "Written Off" Accounts	9,577	9,429	up	148
TOTAL MATURITIES UNPAID	$ 34,359	$ 34,105	up	$ 254
Percentage "Written Off" to Total Loans	0.33	0.35	down	0.02
Percentage Matured Loans in Arrears plus Amount "Written Off" to Total Loans	1.17	1.2	down	0.03
Interest Received	$ 250,379	$ 242,973	up	$ 7,406
Times Interest Received to Matured Loans in Arrears plus Amount "Written Off"	7.48	7.5	down	0.02
NOTES OUTSTANDING	$ 876,816	$ 699,350	up	$177,466

UNIVERSITY AND COMMUNITY

(Concluded from page 242)

One of my associates has recently observed that the layman sees little of science but its slums. He fails to see its great cathedrals — the intricately beautiful and always unfinished intellectual structures and concepts which are the real works of science. It is the mission of the university to work on these great cathedrals of the mind and spirit in all fields, and to possess the sense of striving which makes the cathedrals, and not the slums, the primary goal in all that we undertake.

If we can agree that one of the great ends of life is the indefatigable pursuit of the secrets of man and nature and virtue, then we can bend the material and the utilitarian to noble uses and we can find in the output of the creative mind the outlines of a better future. Instead of despair, we can hope for progress; instead of ugliness and evil, we can hope for more comeliness and virtue; instead of the darkness of ignorance, we can hope for new enlightenment. These hopes and possibilities can never fade when gifted minds and generous spirits come together to seek, to dream, and to understand.

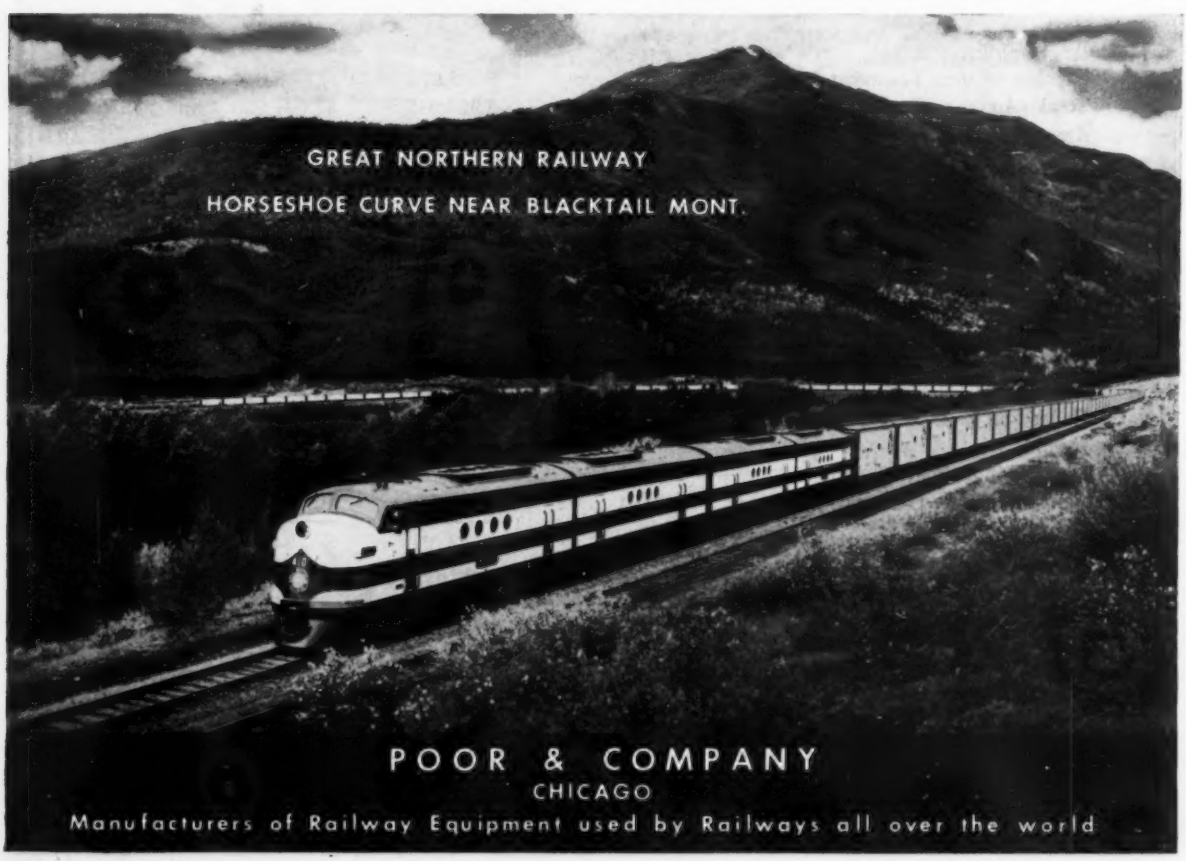
These are some of the observations, the anticipations, and the feelings of optimism which are prompted by the inauguration of this graduate school. We salute it as a new resource for the community and the nation and we hope for it a great role in man's search for understanding.

PREMEDICAL EDUCATION AT M.I.T.

(Continued from page 251)

indeed premedical students, so the Biology Department has assumed the responsibility of making its curriculum especially suitable for these students. The Biology Course has been designed so that a premedical student enrolled here may easily satisfy all medical school course prerequisites. Indeed the specific requirements for graduation in biology include all the prerequisites in biology, physics, chemistry, and humanities for most medical schools. Also sufficient elective time is provided for foreign language courses and for additional work as desired. A course in comparative anatomy is offered by the Biology Department for those premedical students who find it required, or desirable, for the medical school of their choice, although this course is not ordinarily required for medical school or for graduation in biology. In addition, more advanced courses are offered in physiology, biochemistry, and biophysics to which a premedical student would not ordinarily be exposed. The student has the opportunity through his thesis to engage actively in research in some field of biology. This should be very valuable in his future medical career to a small extent because of the factual results of his research, and to a much larger extent because of a knowledge of research techniques and a knowledge of the limitations of the present concepts in biology.

(Continued on page 264)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Harold E. Koch, '22, President
Elton E. Staples, '26, Vice President

PREMEDICAL EDUCATION AT M.I.T.

(Continued from page 262)

The Biology Department maintains a very close relationship to the medical profession. Two members of its faculty are physicians. Several members of the Department's staff are physicians who maintain research laboratories in nearby hospitals – the Massachusetts General Hospital, Peter Bent Brigham Hospital, and the Children's Medical Center. In addition, the Biology Department has undertaken and has continued for several years a program of postgraduate training in biochemistry, biophysics, and cellular physiology for physicians. There are, at the present time, about eight physicians actively engaged as students in this program. Thus, the Biology Department is constantly aware of the trends, opinions, and problems of the medical profession.

There have been several innovations at M.I.T. which should be of assistance to premedical students. An adviser to premedical students has been appointed who is on the faculty of the Biology Department. At the present time the writer serves as this adviser. The Biology Department is a natural choice for a guidance center for premedical students because approximately half of all such students are enrolled in this Department; the other half are divided among the 19 other departments. The duties of the adviser include: the guidance of premedical students; collecting and disseminating information on admission to medical and dental schools, and the current military status of premedical students; the interviewing of students; the writing of letters of recommendation for entrance to medical school when required.

Further recent innovations of interest to premedical students are as follows: The Biology Department has moved into a new building (*see* The Review, December, 1953) which affords more suitable teaching and research facilities. A Division of Biochemistry under the leadership of Professor John M. Buchanan has been established within the Department of Biology, to place greater emphasis on teaching and research in biochemistry.

Specifically for premedical students, a seminar on group psychodynamics has been established and is well into its second year of operation under the direction of Dr. Herbert I. Harris and Dr. Preston K. Munter of the Institute's Medical Department. This consists of the voluntary meeting of groups of six to 10 premedical students with a psychiatrist for an hour at weekly intervals for open discussion, under skilled guidance, of the problems of premedical students. The primary reason for these groups is the belief that a physician can better understand, and more ably treat, the problems of his patients if he first has some understanding of his own problems. This is in no way a course in medicine, but is simply an attempt to unearth some of the problems of prospective physicians, to discuss them, understand them and perhaps to learn to solve or to live with them. There are, of course, many secondary advantages to be derived from this type of program, such as a special study of the problems which later handicap physicians, discussion with students who are uncertain of their desire

(Concluded on page 266)

diversification:

another reason why

Lockheed in

California offers...

better careers for engineers

diversified production

Huge luxury airliners, cargo transports, fighters, bombers, trainers and radar search planes are rolling off Lockheed assembly lines. Twelve models are in production.

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The most diversified development program in Lockheed's history is under way—and it is still growing. The many types of aircraft now in development indicate Lockheed's production in the future will be as varied as it is today—and has been in the past.

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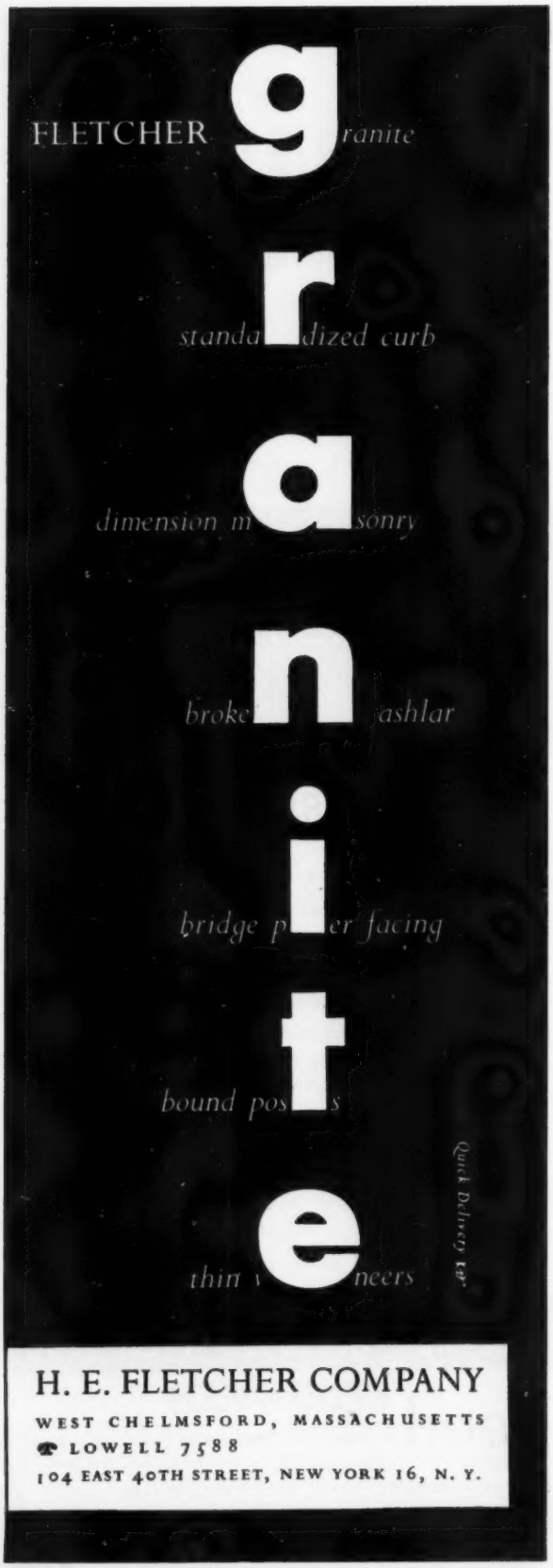

PREMEDICAL EDUCATION AT M.I.T.

(Concluded from page 264)

to enter medicine, and discovery and correction of problems induced by life at M.I.T.

M.I.T. as a center of premedical education has, perhaps, most often been criticized because of the extreme emphasis on science. At the present time the humanities and social sciences are being strengthened by a very active faculty and a revised curriculum. Any further progress in this direction will be most welcome to future physicians. At present, eight semesters of class work in these fields are required of every undergraduate (and two more can now be elected by any student). This exceeds the requirements of most liberal arts colleges.

Now, how can one evaluate the premedical program at M.I.T.? The records of our students in the Medical College Admission Test are at the very top and so are most encouraging. This is an aptitude and achievement examination required for admission to almost all medical schools. The percentage of M.I.T. students accepted over the past few years for admission to medical school is essentially 100 per cent. The academic records of M.I.T. Alumni in medical school are definitely above average.

This represents all the available factual information to evaluate the premedical program and it should be realized that this is not sufficient to indicate how well M.I.T. Alumni succeed as physicians. Our records indicate that an unusually high percentage of our medical Alumni engage in medical research, and that M.I.T. Alumni are generally successful, either in medical research or practice. These records are not complete. Sorely needed is a detailed comparative study* of case histories of Alumni who have been engaging in the practice of medicine or medical research over a period of years. In addition, we have been guided in evaluating this program by opinions expressed by educators from medical schools throughout the country. These opinions are subjective, based on a wealth of experience, and are uniformly favorable toward our policy and educational philosophy.

There is, then, at M.I.T. an actively growing, constantly improving, program of premedical education, based on the soundest judgment and facts available, which measures up to the high standards of M.I.T.

* A study such as that of Anne Roe, "A Psychologist Examines 64 Eminent Scientists," *Scientific American*, **187**:21, No. 5 (1952).

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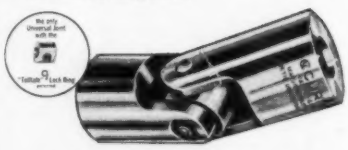

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MINING IN NEW ENGLAND

(Continued from page 250)

Clarke who started a furnace in New Haven in 1658. A fairly extensive body of iron ore, mostly limonite, existed in the northwestern part of Connecticut and extended into adjacent areas of New York and Massachusetts. From this ore, excellent iron was produced and at one time was used in the production of what were reported to be the best cast-iron car wheels in the country. In 1840 Connecticut ranked fourth among the states as a producer of iron products.

The property known as Ore Hill in the Salisbury district was one of the most active producers and supplied ore to a number of furnaces from before 1762 to about 1923. Ethan Allen and John Hazeltine established a furnace at Ore Hill in 1762 but sold it in 1765. It had a capacity of two and a half tons of pig iron in 24 hours.

At the outbreak of the American Revolution the owner of this property was a Tory who fled to England and the plant was seized by Governor Trumbull in the name of the state and operated throughout the war. Cannon, cannon balls, pots, kettles, and army equipment were produced in quantity. The furnace continued to operate after the Revolution and supplied guns for the *Constitution* and *Constellation*.

During the Civil War considerable iron was produced in this district for the naval "ironclads." It has been estimated that during its life the Connecticut section of the Salisbury deposit produced over 4,000,000 tons of ore and about the same amount was mined in the New York and Massachusetts sections combined. Eleven blast furnaces were in operation in 1837 in Connecticut, producing 6,000 tons of pig iron per year. Later there were 26 blast furnaces in operation – 22 of which were in the Salisbury district.

The only lead mine in Connecticut was located near Middletown in Middlesex County. The site was first granted to John Winthrop, Jr., in 1661. The smelting of sulfide lead ore required special skill and since many of the experienced men were pledged to the king not to operate in the colonies it was difficult to find trained personnel. Some men were found in New York and in New Jersey in 1775, but in 1778 they reported that the mine could not operate profitably.

A copper deposit was found in the northern part of Simsbury (now East Granby) and a company of local men was formed in 1707 to develop it. The town was

(Continued on page 270)

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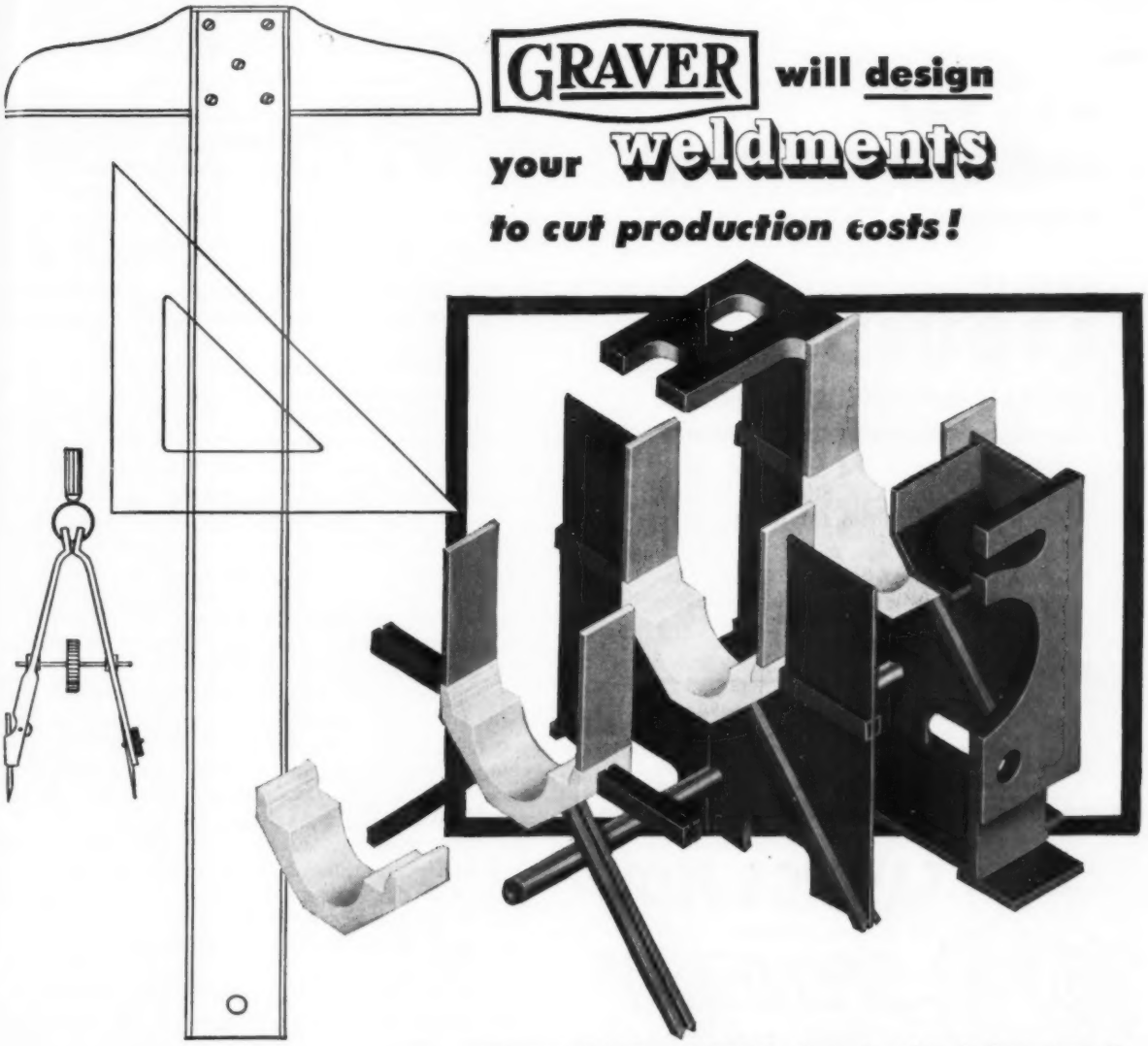

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MINING IN NEW ENGLAND

(Continued from page 268)

to be paid 10 shillings for each ton of copper produced, the proceeds to be used for paying the school teacher. The early operations were unsuccessful but in 1714 it was reopened with the aid of capital furnished by Jonathan Belcher of Boston, William Partridge, and Timothy Woodbridge, and later joined by Andrew Freeman and Charles Cornelia of New York. In 1735 Governor Belcher reported that he had expended about $75,000 in the business and had erected a smelting plant in Boston.

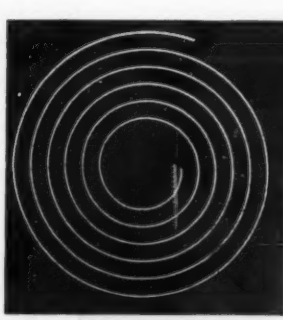
This mine was operated with varying success until 1773. During this period several shafts were sunk – one to a depth of 80 feet – and the ore was found to average 3 to 5 per cent copper. The shape of the ore body was such that several large chambers were excavated during the mining operations, and when the mine was closed, the suggestion that it be used as a prison was adopted. It continued to be used as such for 37 years, among the prisoners being Tories confined during the early days of the American Revolution. In 1830 and again in 1855 attempts were made to mine ore profitably but they failed. The mine is now maintained as a museum.

A copper deposit was discovered at Bristol in the early 1790's but at first only a small amount of ore was mined. The mine was reopened in 1836 but the company went bankrupt in 1846. New owners took over in 1847 but they, too, were unsuccessful. Thirty years later another futile attempt was made to operate the mine profitably. Eight shafts, the deepest 400 feet, and several thousand feet of drifts had been excavated in the various operations. The property is famous for the excellent chalcocite crystals, which are highly prized in mineralogical collections.

A tungsten deposit occurs at Trumbull. It was discovered in 1887 and has attracted some interest because the United States is deficient in this metal, but thus far attempts to operate it profitably have failed.

During World War II the New England Lime Company operated a government-owned plant at Canaan for the production of magnesium from dolomite rock. Some calcium was also made in this plant by a similar process. The method used at this plant for magnesium cannot compete, without the government subsidy then in force, with the process used for producing magnesium from sea water which supplies most of the mag-

(Continued on page 272)



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". . . It may well be that the supply of professional managers may determine the fate of our civilization. Adequate supply coupled with further development of the science of managing is needed, because the fulfillment of human wants demands organized human effort on an ever-increasing scale.

People today, as always, are seeking more comforts and less drudgery as well as protection from the hazards of life. Today the outstanding hazards are war, unemployment, illness, old age, and dependency of loved ones. The comforts being sought are the age old ones of food, shelter, and clothing, and the newer ones of education, recreation, and personal freedom and development.

If professional managers fail to meet these objectives, some short-sighted politicians are likely to lead the people to give up their economic and political freedoms, thereby freezing the economy into low-level production.

Professional managing is a calling in which one puts special knowledge to use with broad human understanding in the services of not only himself and his employers, but also in the service of his employees, his customers, and the community and nation.

This is a very different way of managing from the pre-Civil War slavery in the South and autocratic empire building in the industrial North. It has come about in this twentieth century. It is a professional kind of job.

The feudal concept that first dominated the industrial world has been replaced by business organizations which operate in the interest of, and by the consent of, owners, employees, customers, and the public. The managers are professional employees. The ownership is diffused. Such organizations put to work the people's savings. They provide the best means to gain the benefits sought by the people at large.

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E. S. LEE

Mr. Lee is Editor of the General Electric Review

". . . The prophecy made years ago by Dr. Steinmetz that the electrical age—and the electrical industry—was in its infancy, can still be made today. In 1935 the electrical manufacturing industry supplied only 1.7 percent of the gross national product. Today it supplies 4 percent. There are those who forecast that as early as 1961 the products of electrical manufacturing will represent an estimated 5½ to 6 percent of the gross national product.

The forecasters have been busy, too, drawing dotted lines to show the probable kilowatt-hour output of electric power in the years ahead. A once daring prediction of one-trillion kilowatt-hours for the year 1970 is now moved ahead to 1965, and the really long-range prophets are talking among themselves about an annual output of five-trillion kilowatt-hours by the year 2000.

By virtue of its position, the electrical industry must be prepared to grow more than twice as fast as the remainder of the economy. Based on the best estimates of the growth of the economy as a whole, it is probable that in the next 10 years as much electrical generating equipment will be built, sold, and installed as has been built and installed in the industry's past 75-year history.

What a prospect for the engineer! Such growth means the solution of new and more complex technical problems, together with the advancement of managing ability to solve the many human problems that come with the expanded units of production. In both of these realms the call for solutions is intense. In ever-expanding avenues the opportunity for the new is more extensive than ever.

G.E. Review

J. K. WOLFE

Dr. Wolfe is a Research Associate at the General Electric Research Laboratory

". . . Recently, a new class of fluorine compounds, namely 'fluorocarbons' have appeared which show promise of considerable commercial as well as scientific interest.

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Some of the more recent developments of fluorocarbon derivatives are just beginning to open more fields. The initial high prices of these materials will undoubtedly be decreased as the volume and use becomes more extensive. The price will undoubtedly follow the established pattern as production increases and there are many other places where you will see fluorocarbons occupying a very important spot in the future.

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MINING IN NEW ENGLAND

(Continued from page 270)

nesium now used. New England has plenty of sea water but with the climate handicap it is doubtful if it can compete with the plant on the Gulf Coast.

Quarrying in New England

It would be inappropriate to close this discussion without a few words about quarrying which has many things in common with mining. Excellent granite is found in several places in each of the New England states. It was not extensively used in colonial times, but as quarry tools and techniques developed in the Nineteenth Century, its use increased for building stone monuments.

The construction of Bunker Hill Monument in Charlestown, and of such buildings as King's Chapel and the old Custom House in Boston, gave impetus to the quarrying of building stone; and the development of cutting and polishing devices made granite a competitor of marble for monuments and finely finished ornamental building stone.

Such centers as Barre, Vt., Westerly, R. I., Quincy, Mass., and a few other places still maintain a high reputation for polished stone used for gravestones, other monuments, and building trimmings.

Marble was easily worked and was widely used in early times for various purposes. Maine has limestone

(Continued on page 274)

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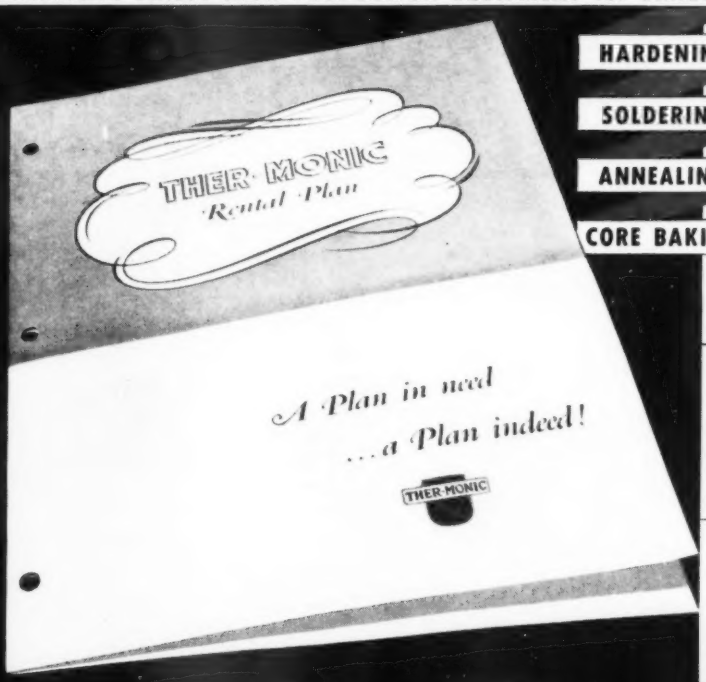

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MINING IN NEW ENGLAND

(Continued from page 272)

in quantity suitable for burning to make lime but the true marble belt extends from Connecticut through the Berkshires of Massachusetts into Vermont.

One of the first marble quarries was opened in 1785. The earliest important contribution to marble quarrying was made by Philo Tomlinson at Marble Dale in New Milford, Conn., where operations were begun just before 1800. Although Tomlinson did not invent the method for cutting marble with a smooth wire and sand, he greatly improved the procedures and made an important contribution to marble working which encouraged its use in thin slabs.

Marble for the Connecticut state capitol at Hartford was quarried at East Canaan. Just north of this point, in Sheffield, Mass., a quarry furnished the large marble columns for Girard College.

Various other quarries operated for a time profitably at Great Barrington, Lee, and West Stockbridge, Mass., and the New York City Hall built in 1803–1811 was faced with marble from Alford, Mass. A quarry at Lee furnished marble for an extension of the National Capitol in 1867 and for Philadelphia City Hall in 1885. Public contracts from 1804 to 1880 were supplied from Berkshire County.

Aside from the quarry at Dorset, Vt., previously mentioned quarries were developed in quick succession in various parts of that state — the most important being in the vicinity of Rutland. The Vermont Marble Company at Proctor, near Rutland, quarries and works marble from this district as well as other districts, and has today a world-wide reputation as a producer of fine stone for buildings and sculptures.

Slate has been produced in several of the New England States but the industry has never been of great importance in this region.

And so ends a rambling discussion of mining and quarrying activities in New England. Some have become wealthy in these pursuits, some have made a living, and others have lost money, but the age-old wrestle with Mother Earth to get accessories for what we call civilization never loses its interest. It would take a wiser man than the present writer to predict what the future holds in store in this section of our country for those who have the wisdom and courage to extend the successes and build on the failures of those who have gone before.

Bibliography

1. Swank, James M., *History of the Manufacture of Iron in All Ages* (Philadelphia: American Iron and Steel Association, 1892).
2. Woodbury, C. J. H., *The Saugus Iron Works* (Lynn: Nichols, 1892).
3. Hartley, E. N., First Iron Works Association.
4. Rickard, Thomas A., *A History of American Mining* (New York: McGraw-Hill Book Company, Inc., 1932).
5. Whitney, Josiah D., *Metallic Wealth of the United States* (Philadelphia: Lippincott, Grambo and Company, 1854).

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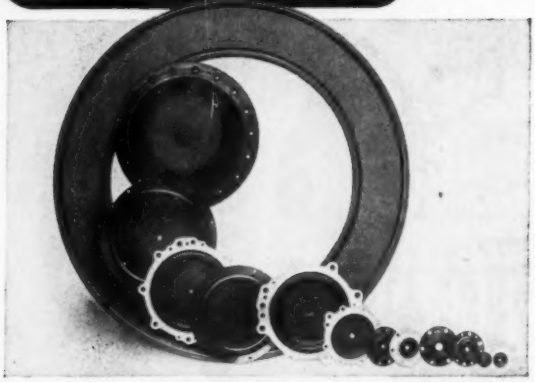

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(Continued from page 274)

6. Winthrop, John, *History of New England* (New York: Charles Scribner's Sons, 1908).

7. Higginson, Francis, *New England's Plantation*, Massachusetts Historical Society Collections, **I**: 117.

8. Weed, W. H., "Copper Deposits of the Appalachian States," *U. S. Geological Survey*, Bulletin 455 (1911).

9. Douglas, William, *Summary of British Settlements.*

10. Kemp, James F., *Ore Deposits of the United States* (New York: Scientific Publications Company, 1893).

11. Bartlett, F. L., *Minerals of New England, Where and How to Find Them* (Portland, Maine: Dresser, McLellan and Company, 1877).

12. Bishop, J. Leander, *History of American Manufactures* (Philadelphia: E. Young and Company, 1864).

13. "Strategic Minerals in New England," *Journal of Chemical Education*, Volume 22 (1945).

14. Earl, Kenneth M., "Investigation of the Douglas Copper Deposit, Hancock County, Maine," *U. S. Bureau of Mines*, R. I., 4701 (1950).

15. Perkins, Virginia Chase, "Mining Boom in Maine," *New England Quarterly* (September, 1941).

16. Levin, S. B., and Sanford, R. S., *U. S. Bureau of Mines*, R. I. 4344 (1948).

17. Emmons, A. B., *Transactions, American Institute of Mining Engineers*, **13**: 510–517.

18. Holley, A. L., *Transactions, American Institute of Mining Engineers*, **6**: 224–227.

19. Toppan, Frederick W., *The Geology of Maine* (Schenectady: Union College [Thesis], 1932).

20. Emmons, William H., "Some Ore Deposits in Maine and in the Milan Mine in New Hampshire," *U. S. Geological Survey*, Bulletin 432 (1910).

21. "Aroostook Manganese Ores," *U. S. Bureau of Mines*, R. I., 4951 (1953).

22. Smith, George Otis, *Mines in Oxford County, Maine.*

23. Bartlett, F. L., *Mines of Maine* (Portland, Maine: B. Thurston Company, 1879–1880).

24. Hitchcock, Charles H., *Geology of the Ammonoosuc Mining District* (Concord, N. H.: E. A. Jenks, 1878).

25. Hitchcock, Edward, *American Journal of Science*, **22**: 1–70.

26. Jackson, Charles T., *Geology of New Hampshire* (Concord, N. H., 1844).

27. Earl, Kenneth M., "Investigation of Milan Copper Deposit," *U. S. Bureau of Mines*, R. I. 4718 (1950).

28. Johnson, Roy, "A Report of Iron Ore in New Hampshire" (Durham: University of New Hampshire, Department of Geology, 1952).

29. Hermance, H. P., and Mosier, McHenry, "Ore Hill

(Concluded on page 278)

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(Concluded from page 276)

Zinc and Lead Mine, Grafton County, N. H.," *U. S. Bureau of Mines*, R. I. 4328 (1948).

30. Spargo, John, *Iron Mining and Smelting at Bennington, Vt.*

31. Crane, Charles E., *Let Me Show You Vermont* (New York: Alfred A. Knopf, 1937).

32. "Hematite in Franklin County Vt.," *Transactions, American Institute of Mining Engineers*, Volume XIII (1885).

33. Emerson, B. K., "Geology of Old Hampshire County," *U. S. Geological Survey*, Monograph No. 29 (1898).

34. Nash, A., *American Journal of Science*, 1st Series, Volume 12.

35. Richards, Robert H., "The Newburyport Silver Mine," *Transactions, American Institute of Mining Engineers*, Volume 3.

36. Howe, Henry F., *Salt Rivers of Massachusetts Shores* (New York: Rinehart and Company, Inc., 1951).

37. Evarts, L. H., *History of the Connecticut Valley.*

38. Rutledge, J. J., "Davis Pyrite Mine," *Engineering and Mining Journal*, Volume LXXXII (1906).

39. "The Williston Lead Mine Near Northampton, Mass.," *Mining Magazine*, Volume 2 (1852).

40. Dennen, William N., "The Dracut Nickel Mine," *Economic Geology*, Volume 38 (1943).

41. Johnson, B. L., and Warren, C. H., "Iron Mine Hill," R. I. 1 *Journal of Science*, **25**: 1–12).

42. Quinn, A., and Young, J. A., "Copper Mine Hill," R. I., *American Mineralogist*, **22**: 279–289.

43. Harte, Charles Rufus, "Connecticut Iron and Copper." Connecticut Society of Civil Engineering 60th Annual Report (1944).

44. "The Salisbury Iron Mine," *Economic Geology*, Volume 2, (1907).

45. "The Salisbury, Conn., Iron Mine," *Transactions, American Institute of Mining Engineers*, **6**: 220.

46. Shepard, Charles U., *Report on the Geological Survey of Connecticut* (New Haven: Hamlen, 1837).

47. Phelps, Noah A., *History of Granby* (Hartford: Case, Tiffany and Burnham, 1845).

48. Trumbull, *History of Connecticut*, Volume II (New Haven: Maltby, Goldsmith and Company).

49. Lewis, James F., "Iron Works East of the Hudson River," *Transactions, American Institute of Mining Engineers*, Volume 5 (1876).

50. Seely, Henry M., "Marble Fields and Marble Industry of Western New England," *Middlebury Historical Society*, Volume I, Part III (1885).

51. Lutjen, George P., and Kearney, John A., "New Life for Vermont's 160-Year-Old Copper Mine," *Engineering and Mining Journal*, **154**: 72, No. 10 (October, 1953).

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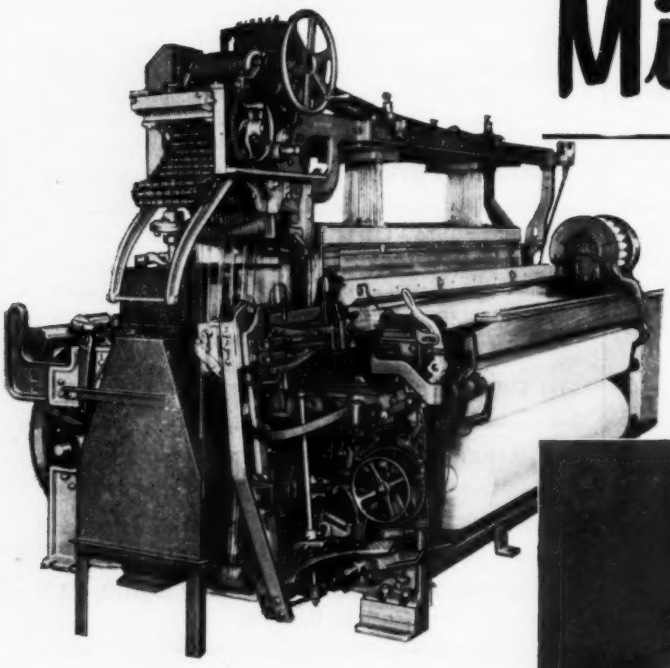

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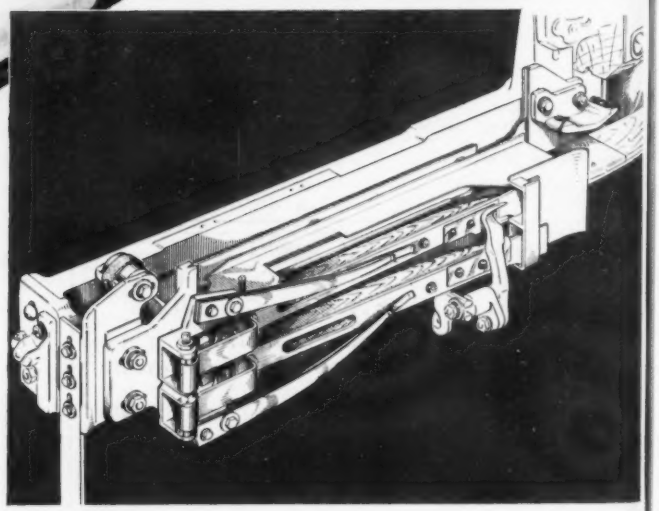

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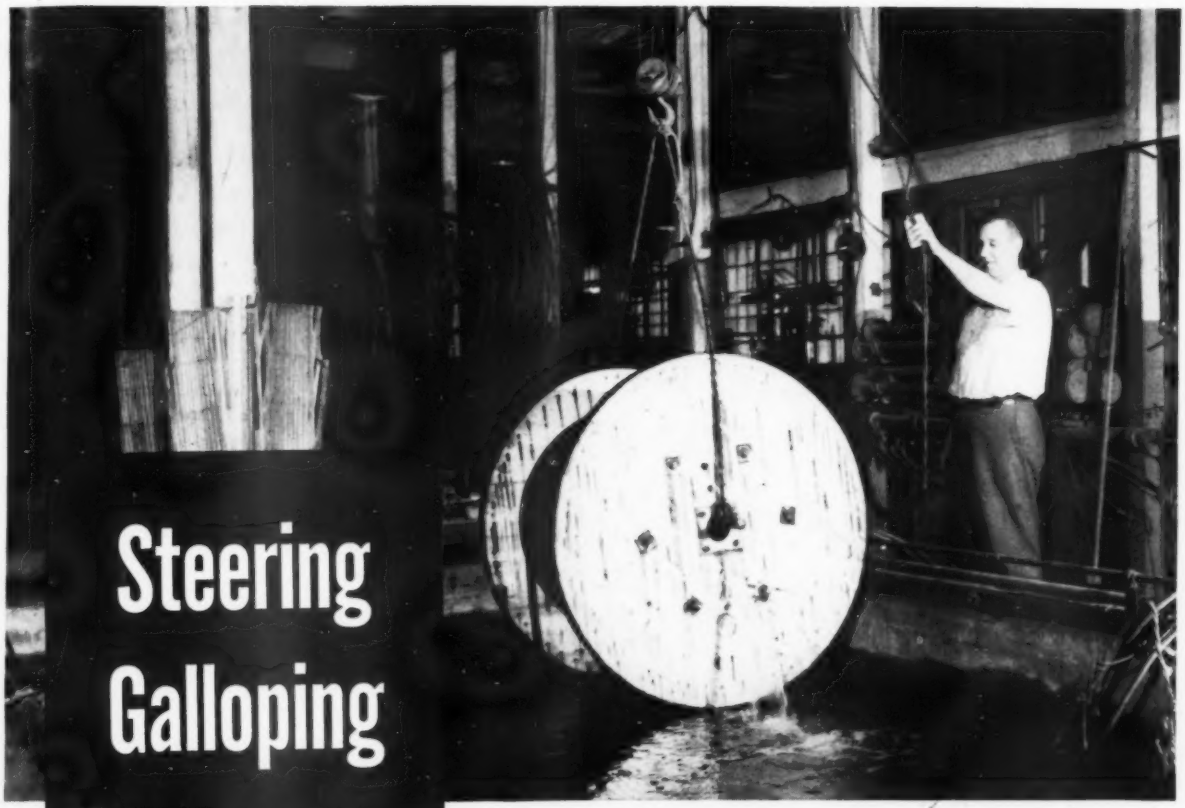

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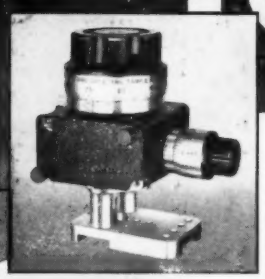

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